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ANNUAL REPORT

OF THE

SECRETARY OF WAR

FOR

THE YEAR 1886.

IN FOUR VOLUMES.

VOLUME II.
PART 1.

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ERRATA FOR ANNUAL REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY, FOR 1886.

Page 541.—Heading Improvement of navigation in the Back Cove, Portsmouth Harbor, New Hampshire, should read— Improvement of navigation in the channel of Back Cove, Portland, Maine.

Page 555.—In estimate, fourth line, change $2 to $1

Page 1161.—First line, after the word presumably, insert interested

Page 1165.—Fourth line from bottom, change 30 feet to 80 feet

Page 1171.—Paragraph 2, first line change 1870 to 1876,

Page 1176.—Seventh line from bottom, change 4 to 5

Page 1208.—Fifteenth line from bottom, change $15,154.83 to $15,164.83.

Page 1230.—Third paragraph from bottom, third line, change those short crises to three short rises

Page 1231.—Second table, 6th column, box heading, 29 feet should be 26 feet

First table, 9th column, box heading 29 feet should be 26 feet

Page 1246.—Ending fourth paragraph insert, Major Stickney in his report of 1884, saying "the detailed plans for locks not being completed, no new estimate is presented, but it is probable that the cost of such locks as are deemed suitable for the work will increase the estimate somewhat."

Page 1252.—End of fourteenth line, change 0.0 feet to 0.05 feet

Fifteenth line, change 8.5 to .85

Twenty-first line, change 25 to .25

Page 1257.—Last paragraph, second line, change 74.07 to 7,407

Page 1258.—Ninth line, change feet to inch

Page 1263.—To follow improvement of bayou Courtableau, Louisiana, insert:

Appropriations for this work have been as follows:

June 14, 1880	$7,500
March 3, 1881	7,500
July 5, 1884	4,000
Total	19,000.

Page 1267.—Fifth paragraph, third line, change $100,000 to $109,000;

Page 1274.—Fifth paragraph, second line, change instrument to investment.

Page 1277.—Fourth paragraph, eleventh line, be subjected should be not subjected.

Page 1278.—Fourth paragraph, sixth line, change 188.40 to 10,840

Eighth paragraph, seventh line, change rest to crest

Page 1279.—Sixth paragraph, fourth line, change 664,364 to 66,436.4

Page 1283.—For last paragraph insert:

Generally considered there has been a deepening since 1881 of from 1 to 2½ feet over the whole area between the jetties, the greatest scour having taken place in the deepest water. The improvement in depth has extended for a distance of 2,000 feet beyond the end of the east jetty, though to a less degree than within. Beyond this there is a small area where no change has occurred, while beyond this again there has been a shoaling of four-tenths of a foot in the line of the channel and out to a depth of 12 feet.

Behind the west jetty the water has shoaled from 1 to 4 feet, the greatest shoaling being found near the shore. From a point 1,000 feet beyond the "Clifton" and between the new channel and the foundation of the west jetty, laid in 1883, there has been a shoaling which extends out to the 12-foot depth. The decrease in depth is greatest near the jetty, and diminishes gradually toward the eastward. The bottom over this area is hard sand, and it is evident that the shoaling has been due to the banking up of the westerly sand-drift against the west jetty; for in 1884 this sand bottom was found to extend 1¼ miles to the eastward of the west jetty, while now sand is only found in isolated spots farther to the eastward than 1,800 feet from the west jetty, and at certain points it completely covers the foundation and has overflowed to the west of the jetty.

Page 1284.—Omit paragraph (second from bottom) beginning with Behind the west jetty, &c.

Page 1287.—Fourth paragraph, second line, change 700 to 7,000

Page 1325.—Fifth and sixth lines, change $14,451 to $14,541

Page 1327.—Four lines from bottom, change 720 to 750

Page 1329.—Fourth paragraph, fourth line, change 4,027,636 to 4,027.636.

Fourth paragraph, seventh line, change 14,566,616 to 14,566.616.

Page 1332.—Fifth paragraph, third line, change station No. 1 to station No. 4

Page 1334.—Under heading Improvement of Harbor at Brazos Santiago, Texas, change appropriated 1885–'86 to appropriated 1880-'86

Page 1341.—Paragraph next to the last, second line, change 1885 to 1884

Page 1342.—Fortieth line, change 727,049.10 to 725,049.10

Page 1344.—Paragraph 2, tenth line, change drains to draws

Page 1345.—Paragraph 6, sixteenth line, change 1879 to 1877

Page 1358.—Under commercial statistics, after the words lumber and timber feet B. M., change 100,000 to 1,100,000

Page 1363.—Six lines from bottom, change 1880 to 1883.

Page 1372.—Paragraph 5, eleventh line, change two hundred and thirty to three hundred and twenty

Page 1400.—Paragraph 5, last line, change $12,000 to $2,000.

Page 1421.—Above money statement insert:

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878	$250,000
By act approved March 3, 1879*	100,000
By act approved June 14, 1880	150,000
By act approved March 3, 1881	200,000
By act passed August 2, 1882	250,000
By act approved July 5, 1884	250,000
Total	1,200,000

Page 1422.—Eleventh line from bottom change 4 to 3

Page 1447.—Third paragraph, ninth line, change 1854 to 1864,

Page 1451.—Sixth paragraph, sixth line, after cubic yard insert of rock

Page 1455.—Last paragraph, first line, change Dutch to Duck

Page 1461.—First table, fifth column, opposite 1880, insert $4

First table, sixth column, opposite 1880, change $52,052.00 to $6,052.00

Page 1462.—Second table, second column, fifth line, change 6,397.50 to 3,697.50

Page 1463.—Under the head of *Comparison of estimates*, &c., eighth column, fourth line, change 8,968.98 to 8,986.98

Page 1491.—Immediately above the last line insert expended during the fiscal year ending June 30, 1886, including outstanding liabilities, $2,469.46.

Page 1551.—Contract was awarded to John J. Shipman, and was executed under date of September 26, 1885, transpose to precede A A 12.

Page 1594.—Fourth paragraph, second line, change Dano to Dana

Page 1595.—Eighth paragraph after Schoonmaker change chief to civil

Eighth paragraph, end of fourth line, insert the

Second paragraph from bottom, second line, after guard insert crib

Page 1596.—To follow seventh paragraph: The following is from the records kept at the lock for the year.

Ninth paragraph from bottom, second line, between the words up and the insert till

Fifth paragraph from bottom, second line, change lowering to lowered

Page 1597.—Fifth line, change 2,426,300 to 3,426,300

Seventh paragraph from bottom, third line, after the word anything insert of importance

Page 1598.—Fourth paragraph, first line, change belted to bolted

Fifth paragraph, first line, change Kiolin to Kirlin

Beginning seventh paragraph, change for several to the several

Page 1613.—Last line, change 73.2 to 32.7

Page 1614.—Second paragraph, second line, after the word water insert It was maintained 250 days to lock No. 5, and was suspended 47 days by ice and high water,

---

* Twenty thousand dollars set aside for testing Adam's Flume.

Page 1614.—Fifth paragraph, third line, between the and lowest insert next to the

Page 1620.—Third table, fourth column, first line, change $744,400 to $774,400

Page 1635.—Eighth paragraph, fifth line, change $5,726.52 to $6,726.52.

Page 1638.—Fourth paragraph, fourth line, insert feet after 6 and inches after 12

Page 1697.—Last paragraph, first line, change 2.8 inches to 2 feet 8 inches

Page 1705.—Between twenty-fifth and twenty sixth lines insert Coal shipped out by rail, cars 2,400

Page 1762.—Last paragraph, first line, change 1886 to 1866.

Page 1764.—In first paragraph, under heading "Improvement of Muskegon Harbor, Michigan," change the word stream to channel in first line.

Page 1767.—Fourth paragraph from bottom, third line, change 45 to 4.5

Page 1768.—Third paragraph from bottom, last line, after 1868, insert 1869, end crib and after condition insert 123 feet crib work of irregular width built previous to 1866, re-superstructured in 1884, in good condition, and 46 feet of crib work 20 feet wide, built in 1868, re-superstructed in 1884, in good condition.

Page 1769.—Eighth paragraph, change 1886 to 1866

Page 1774.—Second paragraph, fourth line, change 90 feet to 30 feet

Page 1778.—Ninth paragraph, fourth line, after the words paid for insert leaving 46,527 cubic yards which was paid for

Page 1781.—Under Money Statement, tenth line, to follow project, insert modified as proposed

Page 1783.—In second table, third box-heading, Hercules powder, change 1,000 pounds to 4,000 pounds.

Page 1792.—Next to last line, change 1856 to 1855,

Page 1794.—Second paragraph, third line, change 1866 to 1868
Fourth paragraph, seventh line, change the slopes to side slopes

Page 1796.—Eighth paragraph, second line, change 1881 to 1871

Page 1801.—Third paragraph, second line, change constructed to obstructed

Page 1802.—Fifth paragraph, seventh line, after practically insert completed

Page 1823.—Sixth line from bottom, change 223,872 to 323,872

Page 1824.—Fourth line from bottom, change 58,000 to 85,000

Page 1833.—Second table, abstract of bids for supplies opened April 2, 1886, should be as follows:

Abstracts of bids for supplies required for the harbor of refuge, Lake Huron, received and opened by Lieut. Col. O. M. Poe, Corps of Engineers, on April 2, 1886, *in accordance with advertisement dated March* 23, 1886.

No.	Names and residences of bidders.	Painters' supplies.	Ship chandlery.	Hardware.
1	H. D. Edwards & Co., Detroit, Mich *	$45 81		
2	Farrand Williams & Co., Detroit, Mich	50 36		
3	J. P. Donaldson & Co., Detroit, Mich	52 10		
4	T. H. Hinchman & Son, Detroit, Mich	54 20		
5	James E. Davis & Co., Detroit, Mich	54 02		
1	H. D. Edwards & Co., Detroit, Mich *		$189 45	
2	J. P. Donaldson & Co., Detroit, Mich		198 50	
1	James L. Fisher, Detroit, Mich *			$42 35
2	T. B. Rayl & Co., Detroit, Mich			44 50

* Recommended for acceptance.

Page 1836.—Fourth paragraph from bottom, change 20,000 to 20

Page 1860.—Seventh paragraph, second line, change $114,133.64 to $114,183.64

Page 1872.—In abstract of contract, second column, third, fourth, and fifth lines, between the words per and foot insert M

Page 1884.—Under second heading Commercial Statistics, amount of revenue collected should be $156,663.71

Page 1891.—Sixth paragraph from bottom, fourth line, change 1886 to 1885,
Fourth paragraph from bottom, change 500 to 568

Page 1893.—Third paragraph, fourth line, after pier head insert in 1869

CONTENTS.

[Alphabetical Index will be found at the end of each Part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS 3

SEA-COAST AND LAKE FRONTIER DEFENSES.

General discussion 4

ESTIMATES OF APPROPRIATIONS FOR 1887–'88 5

NORTHERN FRONTIER.—Ft. Wayne, Mich., 5; Ft. Porter, N. Y., Ft. Niagara, N. Y., 6; Ft. Ontario, N. Y., Ft. Montgomery, N. Y., 7. THE PENOBSCOT, ME.—Ft. Knox, 7. THE KENNEBEC, ME.—Ft. Popham, 8. PORTLAND, ME.—Ft. Gorges, Ft. Preble, 8; Ft. Scammel, battery on Portland Head, 9; batteries on Cow Id., batteries on Great Hog Id., 10. PORTSMOUTH, N. H., AND NAVY-YARD AT KITTERY, ME.—Ft. McClary, Ft. Constitution, 10; battery on Gerrish's Id., battery on Jerry's Point, 11. BOSTON AND NAVY-YARD AT CHARLESTOWN, MASS.—Ft. Warren, battery at Long Id. Head, Ft. Winthrop, 12; Ft. Independence, 13. NEW BEDFORD, MASS.—Fort at Clark's Point, 14. NARRAGANSETT BAY, R. I.—Ft. Adams, 14; defenses of Dutch Id., 15. NEW LONDON HARBOR AND NAVY-YARD, CONN.—Ft. Trumbull, 15; Ft. Griswold, 16. NEW HAVEN, CONN.—Ft. Hale, 17. NEW YORK AND NAVY-YARD AT BROOKLYN.—Ft. Schuyler, fort at Willets Point, 17; defenses of Governor's Id., sea-wall on Governor's Id., 18; Ft. Wood, Ft. Hamilton and additional batteries, 19; mortar battery at Ft. Hamilton, Ft. Lafayette, Ft. Wadsworth, 20; fort on site of Ft. Tompkins, Glacis Gun Battery (n. of fort on site of Ft. Tompkins), 21; Glacis Mortar Battery (s. of fort on site of Ft. Tompkins), Battery Hudson, 22; South Mortar Battery, North Cliff Battery, 23; South Cliff Battery, Two-gun Battery near fort on site of Ft. Tompkins, fort at Sandy Hook, 24. PHILADELPHIA AND LEAGUE ISLAND NAVY-YARD.—Ft. Mifflin, mortar battery at Ft. Mifflin, 25; site for defenses at Red Bank, Ft. Delaware, 26; battery at Finn's Point, mortar battery at Finn's Point, fort opposite Ft. Delaware, 27; mortar battery opposite Ft. Delaware, 28. BALTIMORE, MD.—Ft. McHenry, 28; Ft. Carroll, 29. WASHINGTON, D. C.—Ft. Foote, 29; Ft. Washington, obstructions of the Potomac, 30. HAMPTON ROADS AND GOSPORT NAVY-YARD, VA.—Ft. Monroe, 30; artesian well at Ft. Monroe, Ft. Wool, 32. BEAUFORT HARBOR, N. C.—Ft. Macon, 33. WILMINGTON, N. C. Ft. Caswell, 34. CHARLESTON, S. C.—Ft. Moultrie, Ft. Sumter, 34; Ft. Johnson, 35; Castle Pinckney, 36. SAVANNAH, GA.—Ft. Oglethorpe, Ft. Pulaski, 36; new fort on Tybee Id., 37. CUMBERLAND SOUND.—Ft. Clinch, 37. SAINT AUGUSTINE, FLA.—Ft. Marion, 38. KEY WEST, FLA.—Ft. Taylor and batteries, 38. HARBOR OF DRY TORTUGAS, FLA.—Ft. Jefferson, 39. PENSACOLA HARBOR AND NAVY-YARD, FLA.—Ft. Pickens, Ft. Barrancas and redoubt, 40; Ft. McRee, 41. MOBILE, ALA.—Ft. Morgan, Ft. Gaines, 41. MISSISSIPPI SOUND.—Fort on Ship Island, 42. NEW ORLEANS, LA.—Ft. Pike, 42; Ft. Macomb, Tower Dupré, Battery Bienvenue, tower at Proctorsville, 43; Ft. Jackson, Ft. St. Philip, Ft. Livingston, 44. GALVESTON, TEX.—Batteries at the entrance to the harbor of Galveston, 45. SAN DIEGO HARBOR, CALIFORNIA.—Fort at San Diego, 45. SAN FRANCISCO, NAVY-YARD AT MARE ISLAND, AND ARSENAL AT BENICIA, CAL.—Ft. Winfield Scott, 45; fort at Lime Point, 46; fort on Alcatraz Id., Ft. Mason, batteries on Angel Id., 47. DEFENSES OF THE COLUMBIA, OREG., AND WASH.—Ft. Stevens, Ft. Canby, 47.

THE BOARD OF ENGINEERS.

Officers constituting Board, Fortifications, 49; *Rivers and Harbors*, 49; *Coast defenses, Torpedo defense*, 50; *Estimate for service of torpedoes*, 51.

POST OF WILLETS POINT AND ENGINEER SCHOOL OF APPLICATION.. 52

BATTALION OF ENGINEERS AND DEPOT AT WILLETS POINT, NEW YORK HARBOR 53

RIVER AND HARBOR IMPROVEMENTS.

General statement 53

ATLANTIC COAST AND GULF OF MEXICO.

In charge of Maj. Jared A. Smith, Corps of Engineers—

Lubec Channel, Me., 54; Bangor Harbor and Penobscot River, Me., Moose-a-bec Bar, Me., 55; Belfast Harbor, Me., Rockland Harbor, Me., 56; Portland Harbor, Me., Kennebunk River, Me., 57; breakwater at mouth of Saco River, Me., Saco River, Me., Portsmouth Harbor, N. H., 58; Cocheco River, N. H., harbor of refuge at Little Harbor, N. H., 59; examination and survey, 60.

In charge of Maj. George L. Gillespie, Corps of Engineers—

Newburyport Harbor, Mass., 60; Merrimac River, Mass., 61; Scituate Harbor, Mass., 62; Boston Harbor, Mass., 63; Plymouth Harbor, Mass., 64; Provincetown Harbor, Mass., Lynn Harbor, Mass., 65; Malden River, Mass., 66; harbor of refuge at Sandy Bay, Cape Ann, Mass., 67.

In charge of Lieut. Col. George H. Elliot, Corps of Engineers—

Harbor of refuge at Hyannis, Mass., harbor of refuge at Nantucket, Mass., 68; Woods Holl Harbor, Mass., 69; Westport Harbor, Mass., Wareham Harbor, Mass., 70; Taunton River, Mass., 72; Pawtucket River, R. I., 73; Providence River and Narragansett Bay, R. I., 74; Green Jacket Shoal, Providence River, R. I., Warren River, R. I., Newport Harbor, R. I., 75; harbor of refuge at Block Island, R. I., 77; Little Narragansett Bay, R. I., harbor of refuge at Stonington, Conn., 78; Pawcatuck River, R. I., and Conn., removing sunken vessels or craft obstructing or endangering navigation, 80.

In charge of Lieut. Col. D. C. Houston, Corps of Engineers—

Connecticut River, Mass. and Conn., 81; Thames River, Conn., 82; New London Harbor, Conn., Clinton Harbor, Conn., 83; New Haven Harbor, Conn., Breakwater at New Haven, Conn., 84; Milford Harbor, Conn., Housatonic River, Conn., 85; Bridgeport Harbor, Conn., 86; Black Rock Harbor, Conn., Southport Harbor, Conn., 87; Norwalk Harbor, Conn., Port Chester Harbor, N. Y., 88; New Rochelle Harbor, N. Y., Echo Harbor, New Rochelle, N. Y., 89; Mamaroneck Harbor, N. Y., Greenport Harbor, N. Y., Port Jefferson Harbor, N. Y., 90; Flushing Bay, N. Y., East Chester Creek, N. Y., 91.

In charge of Lieut. Col. Walter McFarland, Corps of Engineers—

Hudson River, N. Y., 92; harbor at Saugerties, N. Y., 93; harbor at Rondout, N. Y., Harlem River, N. Y., 94; removing obstructions in East River and Hell Gate, N. Y., 95; Newtown Creek, N. Y., 96; Buttermilk Channel, N. Y., 97; Gowanus Bay, N. Y., Gedney's Channel, N. Y., 98; Sheepshead Bay, N. Y., 100; Canarsie Bay, N. Y., 101; Sumpawanus Inlet, N. Y., Manasquan River, N. J., 102; Shrewsbury River, N. J., 103; harbor at Keyport, N. J., Mattawan Creek, N. J., 105; Cheesequakes Creek, N. J., Raritan Bay, N. J., 106; Raritan River, N. J., 107; South River, N. J., 108; Woodbridge Creek, N. J., Rahway River, N. J., 109; Elizabeth River, N. J., channel between Staten Island and New Jersey, 110; Passaic River, N. J., 111.

In charge of Lieut. Col. Henry M. Robert, Corps of Engineers—

Delaware River from Trenton, N. J., to its mouth, 113; Delaware River at Schooner Ledge, Delaware River near Cherry Island Flats, 115; Frankford Creek, Pa., Schuylkill River, Pa., 116; ice-harbor at Marcus Hook, Pa., 117; ice-harbor at the head of Delaware Bay, Del., construction of iron pier in Delaware Bay, near Lewes, Del., 118; Delaware Breakwater Harbor, Del., 119; Rancocas River, N. J., 120; Woodbury Creek, N. J., Mantua Creek, N. J., Raccoon River, N. J., 121; Salem River, N. J., Cohansey Creek, N. J., 122; removal of wrecks from Delaware Bay and River, removing sunken vessels or craft obstructing or endangering navigation, United States commission advisory to the board of harbor commissioners of Philadelphia, Pa., 123.

In charge of Mr. William F. Smith, U. S. Agent—

Maurice River, N. J., Wilmington Harbor, Del., 124; ice-harbor at New Castle, Del., 125; Duck Creek, Del., Saint Jones River, Del., 126; Mispillion Creek, Del., 127; Broadkiln River, Del., Broad Creek, Del., from its mouth to Laurel, 128; Indian River, Del., Susquehanna River above and below Havre de Grace, Md., 129; Chester River at Kent Island Narrows, Md., Chester River from Spry's Landing to Crumpton, Md., 130; Corsica Creek, Md., Choptank River, Md., 131; Wicomico River, Md., Upper Thoroughfare, between Deil's Island and the mainland, Md., 132.

In charge of Lieut. Col. William P. Craighill, Corps of Engineers—

Patapsco River and channel leading to Baltimore, Md., 133; harbor at Annapolis, Md., 134; removing sunken vessels or craft obstructing or endangering navigation, 135.

In charge of Maj. Peter C. Hains, Corps of Engineers, Bvt. Lieut. Col., U. S. A.—

Harbors at Washington and Georgetown, D. C., 135; Potomac River at Washington, D. C., 136; James River, Va., 137; Shenandoah River, W. Va., 139.

In charge of Mr. S. T. Abert, U. S. Agent—

Channel at Mount Vernon, Va., 139; Neabsco Creek, Va.; Breton Bay, Leonardtown, Md., 140; Nomini Creek, Va.; harbor at entrance of Saint Jerome's Creek, Md., 141; Rappahannock River, Va.; Totusky River, Va., 142; Urbana Creek, Va.; Mattaponi River, Va., 143; Pamunky River, Va.; York River, Va., 144; Chickahominy River, Va., 145; Staunton River, Va., 145, 146; Dan River, between Madison, N. C., and Danville, Va., 146; Roanoke River, N. C.; French Broad River, N. C., 147; examination aqueduct bridge, 148.

In charge of Capt. F. A. Hinman, Corps of Engineers—

Harbor at Norfolk, Va., 148; approach to Norfolk Harbor and the (Norfolk) Navy-Yard, between Lambert's Point and Fort Norfolk, Va., 149; Appomattox River, Va., 150; Nottaway River, Va., 151; Blackwater River, Va., Archer's Hope River, Va., 152; North Landing River, Va. and N. C., 153; Edenton Bay, N. C., Currituck Sound, Coanjok Bay, and North River Bar, N. C., 154; Meherrin River, N. C., 155; Pamplico and Tar rivers, N. C., 156; Yadkin River, N. C., 157; Scuppernong River, N. C., 158; removing sunken vessels or craft obstructing or endangering navigation, 159.

In charge of Capt. William H. Bixby, Corps of Engineers—

Contentnea Creek, N. C., 159; Trent River, N. C., 160; Neuse River, N. C., 162; inland navigation from New Berne to Beaufort Harbor, via Clubfoot, Harlowe, and Newport rivers, N. C., 163; harbor at Beaufort, N. C., 164; New River, N. C., 165; Cape Fear River, above Wilmington, N. C., 166; Cape Fear River, below Wilmington, N. C., 168; Great Pe Dee River, S. C., 169; Waccamaw River, S. C., 170; harbor at Georgetown, S. C., 172; Santee River, S. C., 173; Wateree River, S. C., 174; removing sunken vessels obstructing or endangering navigation, 175.

In charge of Col. Q. A. Gillmore, Corps of Engineers, Bvt. Maj. Gen., U. S. A.—

Charleston Harbor, S. C., 176; Wappoo Cut, S. C., 178; Ashley River, S. C., Edisto River, S. C., 179; Salkiehatchie River, S. C., 180; Savannah Harbor and River, Ga., 181; Savannah River, Ga., 183; Savannah River above Augusta, Ga., 184; Saint Augustine Creek (Thunderbolt River), Ga., Romerly Marsh, Ga., 185; Altamaha River, Ga., 186; Brunswick Harbor, Ga., 187; entrance to Cumberland Sound, Ga. and Fla., 189; inside passage between Fernandina and Saint John's River, Fla., 190.

In charge of First Lieut. Wm. M. Black, Corps of Engineers—

Saint John's River, Fla., 190; Upper Saint John's River, Fla., 191; Volusia Bar, Fla., Tampa Bay, Fla., 192; Apalachicola Bay, Fla., 193; Suwanee River, Fla., Key West Harbor, Fla., 194; Pease Creek, Fla., harbor at Cedar Keys, Fla., Manatee River, Fla., 195; Caloosahatchie River, Fla., Apalachicola River, Fla., 196; Withlacoochee River, Fla., removing sunken vessels or craft obstructing or endangering navigation, 197.

In charge of Capt. R. L. Hoxie, Corps of Engineers—

Ocmulgee River, Ga., Oconee River, Ga., 198; Flint River, Ga., Oostenaula and Coosawattee rivers, Ga., 199; Coosa River, Ga. and Ala., Chattahoochee River, Ga. and Ala., 200; Alabama River, Ala., Tallapoosa River, Ala., 201; Cahaba River, Ala., 202; Conecuh—Escambia River, Fla. and Ala., Choctawhatchee River, Fla. and Ala., 203; Bayou La Grange, Fla., harbor at Pensacola, Fla, 204.

In charge of Maj. A. N. Damrell, Corps of Engineers—

Mobile Harbor, Ala., 205; Warrior River, Ala., Tombigbee River, from Fulton to Vienna, 206; Tombigbee River, below Vienna, 207; Black Warrior River, from Tuscaloosa to Daniel's Creek, Ala., Old Town Creek, Miss., Noxubee River, Miss., 208; Pascagoula River, Miss., harbor at Biloxi Bay, Miss., 209; Horn Island Pass, Miss., Pearl River, Miss., below Jackson, Pearl River, Miss., from Jackson to Carthage, 210; Pearl River, Miss., between Edinburg and Carthage, 211; examinations and surveys, 211.

In charge of Maj. W. H. Heuer, Corps of Engineers—

Inspection of the improvement at the South Pass of the Mississippi River, 212; Amite River, La., Tangipahoa River, La., 213; Tchefuncte River, La., 214; Tickfaw River, La., Bayou Teche, La., 215; connecting Bayou Teche with Grand Lake at Charenton, La., 216; Bayou Black, La., 217; Bayou Courtableau, La., 218; Bayou Terrebonne, La., Bayou La Fourche, La., 219; Calcasieu River, La., Calcasieu Pass, La., 220; Sabine Pass, Tex., 221; Sabine River, La. and Tex., Neches River, Tex., 222; removing sunken vessel or craft obstructing or endangering navigation, 223.

In charge of Maj. S. M. Mansfield, Corps of Engineers, Bvt. Lieut. Col., U. S. A.—

Entrance to Galveston Harbor, Tex., 223; ship-channel in Galveston Bay, Tex., Trinity River, Tex., 224; Buffalo Bayou, Tex., channel over the bar at the mouth of Brazos River, Tex., Pass Cavado Inlet, to Matagorda Bay, Tex., 225; Aransas Pass and Bay, up to Rockport and Corpus Christi, Tex., harbor at Brazos Santiago, Tex., 226; protection of river-bank at Fort Brown, Tex., 227.

WESTERN RIVERS.

In charge of Capt. Eric Bergland, Corps of Engineers—

Red River, La. and Ark., 227; survey of Bayou Pierre, La., Cypress Bayou, Tex. and La., 229; Cane River, La., Loggy Bayou, Lake Bisteneau, and the Dorcheat, La., Ouachita and Black rivers, Ark. and La., 230; Bayou Bartholomew, La. and Ark., Bayou Bœuf, La., 231; Tensas River and Bayou Macon, La., Bayou D'Arbonne, La., 232; Yazoo River, Miss., 233; Big Sunflower River, Miss., Tchula Lake, Miss., Tallahatchee River, Miss., 234; Yallabusha River, Miss., Steele's Bayou, Miss., 235; Big Black River, Miss., Big Hatchee River, Tenn., 236; South Forked Deer River, Tenn., water-gauges on the Mississippi River and it principal tributaries, 237.

In charge of Capt. H. S. Taber, Corps of Engineers—

Removing obstructions in Arkansas River, Ark., Arkansas River at Pine Bluff, Ark., 238; Black River, Ark. and Mo., White River, Ark., 240; White River, above Buffalo Shoals, Ark., 241; Saint Francis River, 242; Saline River, Ark., L'Anguille River, Ark., 243; surveys, 244.

In charge of Maj. A. M. Miller, Corps of Engineers—

Removing snags and wrecks from the Mississippi and Missouri rivers, 244; Osage River, Kans. and Mo., 246; Gasconade River, Mo., 247.

Mississippi River Commission 247

Missouri River Commission 248

In charge of Capt. C. B. Sears, Corps of Engineers—

Improvement of the Missouri River from Sioux City, Iowa, to Fort Benton, Mont., 248.

In charge of Capt. James B. Quinn, Corps of Engineers—

Improvement of Yellowstone River, Mont. and Dak., 249.

IN CHARGE OF MAJ. O. H. ERNST, CORPS OF ENGINEERS—

Improvement of the Mississippi River from the mouth of the Illinois to the mouth of the Ohio, 249.

IN CHARGE OF CAPT. E. H. RUFFNER, CORPS OF ENGINEERS—

Improvement of the Mississippi River from Des Moines Rapids to the mouth of Illinois River, 249.

IN CHARGE OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS—

Upper Mississippi River, operations of snag-boats and dredge-boats, Mississippi River from Saint Paul to Des Moines Rapids, 250; Mississippi River from Des Moines Rapids to mouth of the Illinois River, harbor of refuge in Lake Pepin, at Stockholm, Wis., harbor of refuge in Lake Pepin, at Lake City, Minn., 251; removal of bar in Mississippi River opposite Dubuque, Iowa, ice-harbor at Dubuque, Iowa, Rock Island Rapids, Mississippi River, 252; Des Moines Rapids, Mississippi River, 253; operating and care of Des Moines Rapids Canal, dry-dock at Des Moines Rapids Canal, 254.

IN CHARGE OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS—

Preservation of Falls of Saint Anthony, Minn., 255; Mississippi River above the Falls of Saint Anthony, Minn., 256; construction of lock and dam on Mississippi River at Meeker's Island, Minn., 257; Chippewa River, Wis., 258; Chippewa River at Yellow Banks, Wis., Saint Croix River below Taylor's Falls, Minn. and Wis., 259; Minnesota River, Minn., 260; Red River of the North, Minn. and Dak., 261; lock and dam at Goose Rapids on Red River of the North, Minn. and Dak., 262; reservoirs upon the headwaters of the Mississippi River, 263; surveys for reservoirs at the sources of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers, 264.

IN CHARGE OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS—

Tennessee River, 264; Cumberland River, 266; Hiawassee River, 267; French Broad River, Tenn., Clinch River, Tenn., 268; Duck River, Tenn., Caney Fork River, Tenn., 269; Little Tennessee River, Tenn., South Fork Cumberland River, Ky., 270.

IN CHARGE OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINEERS, BVT. COL., U. S. A.—

Ohio River, 271; operating and care of Davis Island Dam, Ohio River, 272; Monongahela River, W. Va., and Pa., operating and care of Lock and Dam No. 9, Monongahela River, Allegheny River, Pa., dam at Herr's Island, Allegheny River, 273; ice-harbor at mouth of Muskingum River, Ohio, Muskingum River, Ohio, 274; operating and care of locks and dams on the Muskingum River, Ohio, harbor of refuge near Cincinnati, Ohio, harbor of refuge at mouth of Great Kanawha River, W. Va., 275; examination and survey, 276.

IN CHARGE OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS—

Falls of the Ohio River at Louisville, Ky., Indiana Chute, Falls of the Ohio River, 276; Louisville and Portland Canal, Wabash River, Ind. and Ill., 277; White River, Ind., 279.

IN CHARGE OF LIEUT. COL. W. P. CRAIGHILL, CORPS OF ENGINEERS—

Great Kanawha River, W. Va., 279; Elk River, W. Va.; New River, from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbrier River, W. Va., 281.

IN CHARGE OF CAPT. JAMES C. POST, CORPS OF ENGINEERS—

Kentucky River, Ky., 282; operating and keeping in repair locks and dams on the Kentucky River, Ky., 283; Tradewater River, Ky., Big Sandy River, W. Va. and Ky., 284; Guyandotte River, W. Va., Little Kanawha River, W. Va., 285; Buckhannon River, W. Va., 286.

LAKE HARBORS AND RIVERS.

IN CHARGE OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS—

Harbor at Duluth, Minn., 287; dredging Superior Bay, Wis., 288; harbor at Grand Marais, Minn., 289.

In charge of Capt. Charles E. L. B. Davis, Corps of Engineers—

Ontonagon Harbor, Mich., 290; Eagle Harbor, Mich., Marquette harbor, Mich., 291; harbor of refuge at Grand Marais, Mich., 292; Manistique Harbor, Mich., harbor at mouth of Cedar River, Mich, 293; Menomonee Harbor, Mich. and Wis., Oconto Harbor, Wis., 294; Pensaukee Harbor, Wis., 295; Green Bay Harbor, Wis., harbor of refuge at entrance of Sturgeon Bay Canal, Wis., 296; Ahnepee Harbor, Wis., Kewaunee Harbor, Wis., 297; Two Rivers Harbor, Wis., 298; Manitowoc Harbor, Wis., Sheboygan Harbor, Wis., 299; Port Washington Harbor, Wis., 300; survey, 301.

In charge of Capt. W. L. Marshall, Corps of Engineers—

Harbor of refuge, Milwaukee Bay, Wis., 301; Milwaukee Harbor, Wis., Racine Harbor, Wis., 302; Kenosha Harbor, Wis., Waukegan Harbor, Ill., 303; Fox and Wisconsin rivers, Wis., 304.

In charge of Maj. W. H. H. Benyaurd, Corps of Engineers—

Chicago Harbor, Ill., 306; Calumet Harbor, Ill., 307; Illinois River, Calumet River, 308; survey, 309.

In charge of Capt. D. W. Lockwood, Corps of Engineers—

Charlevoix Harbor, Mich, 309; Frankfort Harbor, Mich., harbor of refuge at Portage Lake, Mich., 310; Manistee Harbor, Mich., 311; Ludington Harbor, Mich., Pentwater Harbor, Mich., 312; White River Harbor, Mich., Muskegon Harbor, Mich., 313; Grand Haven Harbor, Mich., Grand River, Mich., Black Lake Harbor, Mich., 314; Saugatuck Harbor, Mich., South Haven Harbor, Mich., 315; Saint Joseph Harbor, Mich., Michigan City Harbor, Ind., 316.

In charge of Lieut. Col. O. M. Poe, Corps of Efgineers, Bvt. Brig. Gen., U. S. A.—

Hay Lake Channel, Saint Mary's River, Mich., 318; Saint Mary's Falls Canal and River, Mich., operating and care of Saint Mary's Falls Canal, Mich., 319; dry-dock at Saint Mary's Falls Canal, Mich., harbor at Cheboygan, Mich., 320; harbor at Thunder Bay, Mich., harbor at Au Sable, Mich., 321; Saginaw River Mich., harbor of refuge, Sand Beach, Lake Huron, Mich., 322; steam launch or tug for harbor of refuge, Lake Huron, Mich., 323; ice-harbor of refuge at Belle River, Mich., general repairs and renewals at Saint Clair Flats Ship Canal, Mich., 324; operating and care of Saint Clair Flats Canal, Mich., Clinton River, Mich., 325; Detroit River, Mich., 326.

In charge of Maj. L. Cooper Overman, Corps of Engineers—

Monroe Harbor, Mich., 326; Toledo Harbor, Ohio, 327; Port Clinton Harbor, Ohio, 329; Sandusky City Harbor, Ohio, 330; Sandusky River, Ohio, 331; Huron Harbor, Ohio, Vermillion Harbor, Ohio, 332; mouth of Black River, Ohio, 333; Rocky River, Ohio, Cleveland Harbor, Ohio, 334; Fairport Harbor, Ohio, 336; Ashtabula Harbor, Ohio, 337; Conneaut Harbor, Ohio, Dunkirk Harbor, N. Y., 338; removing sunken vessels or craft obstructing or endangering navigation, 339.

In charge of Capt. Edward Maguire, Corps of Engineers—

Erie Harbor, Pa., 339; Buffalo Harbor, N. Y., 340; Niagara River, N. Y., Wilson Harbor, N. Y., Olcott Harbor, N. Y., 341; Oak Orchard Harbor, N. Y., Charlotte Harbor, N. Y., 342; Pultneyville Harbor, N. Y., 343; Great Sodus Harbor, N. Y., Little Sodus Harbor, N. Y., 344; Oswego Harbor, N. Y., 345; Sackett's Harbor, N. Y., 346.

In charge of Maj. Milton B. Adams, Corps of Engineers—

Ogdensburg Harbor, N. Y., 346; Grass River at Massena, N. Y., 347; breakwater at Rouse's Point, Lake Champlain, N. Y., Swanton Harbor, Vt., Plattsburg Harbor, N. Y., 348; Burlington Harbor, Vt., 349; Otter Creek, Vt., Ticonderoga River, N. Y., 350.

PACIFIC COAST.

In charge of Lieut. Col. George H. Mendell, Corps of Engineers—

Oakland Harbor, Cal., 350; Wilmington Harbor, Cal., 351; Redwood Harbor, Cal., removal of sunken vessels or craft obstructing or endangering navigation, 352.

In charge of Col. C. Seaforth Stewart, Corps of Engineers—

Harbor at San Diego, Cal., 353.

In charge of Capt. A. H. Payson, Corps of Engineers—

Humboldt Harbor and Bay, Cal., 353; San Joaquin River, Stockton and Mormon sloughs, Cal., 354; Mokelumne River, Cal., Sacramento and Feather rivers, Cal., 355; Colorado River, Nevada, Cal., and Ariz., 356.

In charge of Maj. W. A. Jones, Corps of Engineers—

Columbia and Willamette rivers below Portland, Oreg., 357; Upper Willamette River, Oreg.; Columbia River at Cascades, Oreg., 358; Upper Columbia and Snake rivers Oreg. and Wash., Cowlitz River, Wash., 359; Lower Clearwater River, Idaho, 360; examinations and surveys, 360.

In charge of Capt. Charles F. Powell, Corps of Engineers—

Mouth of the Columbia River, Oreg., and Wash., 360; entrance to Coos Bay, Oreg., 361; entrance to Yaquina Bay, Oreg., mouth of Coquille River, Oreg., 362; Umpqua River, Oreg., 363; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., Chehalis River, Wash., 364; gauging waters of the Columbia River and principal tributaries, 365.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS.

Estimate for 1887–'88 365

WASHINGTON AQUEDUCT, ETC.

In charge of Maj. G. J. Lydecker, Corps of Engineers—

Washington Aqueduct, 365; increasing the water supply of the city of Washington, 366; erection of fish-ways at the Great Falls of the Potomac River, 368.

PUBLIC BUILDINGS, GROUNDS, ETC., DISTRICT OF COLUMBIA.

In charge of Lieut. Col. John M. Wilson, Corps of Engineers, Colonel, United States Army 368

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Bridge across the Mississippi River at Keithsburg, Ill., stone-arch bridge across the West Channel of the Mississippi River at Minneapolis, Minn., proposed bridge across the Ohio River at or near Cairo, Ill., 369; bridge of the Selma Bridge Company across the Alabama River at Selma, Ala., changes in the original plan of the bridge across the Ohio River at Henderson, Ky, 370.

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTHWESTERN LAKES 371

MILITARY AND GEOGRAPHICAL MAPS 371

RECONNAISSANCES AND EXPLORATIONS.

Officers on duty at headquarters of the Army, of divisions, and departments, 372; reports made, 372, 373; estimate for surveys and reconnaissances and publications of maps, 373.

OFFICE OF THE CHIEF OF ENGINEERS.

Officers of the Corps of Engineers in charge of divisions 374

STATEMENT OF RANK AND DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR.............. 375

LAWS AFFECTING THE CORPS OF ENGINEERS, 49TH CONGRESS, 1ST SESSION, 1885-'86.......................... 395

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF LIEUT. COL. C. B. COMSTOCK, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A.

Post of Willets Point and Engineer School of Application 471

APPENDIX No. 2.

REPORT OF MAJ. W. R. KING, CORPS OF ENGINEERS.

Battalion of Engineers and depot at Willets Point 489

APPENDIX No. 3.

REPORT OF THE BOARD ON FORTIFICATIONS OR OTHER DEFENSES APPOINTED BY THE PRESIDENT OF THE UNITED STATES UNDER THE PROVISIONS OF THE ACT OF CONGRESS APPROVED MARCH 3, 1885. WILLIAM C. ENDICOTT, SECRETARY OF WAR, PRESIDENT 499

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF MAJ. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Lubec Channel, Me., 527; Bangor Harbor and Penobscot River, Me., 530; Moose-a-bec Bar, Me., 533; Belfast Harbor, Me., 535; Rockland Harbor, Me., 536; Portland Harbor, Me., 538; Kennebunk River, Me., 543; breakwater at mouth of Saco River, Me., 544; Saco River, Me., 546; Portsmouth Harbor, N. H., 546; Cocheco River, N. H., 548; examination and survey Saco River, Me., 552.

APPENDIX B.

REPORT OF MAJ. GEORGE L. GILLESPIE, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.

IMPROVEMENTS.—Newburyport Harbor, Mass., 557; Merrimac River, Mass., 560; Scituate Harbor, Mass., 562; Boston Harbor, Mass., 564; Plymouth Harbor, Mass., 571; Provincetown Harbor, Mass., 574; Lynn Harbor, Mass., 577; Malden River, Mass., 579; harbor of refuge at Sandy Bay, Cape Ann, Mass., 580.

APPENDIX C.

REPORT OF LIEUT. COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 585; harbor of refuge at Nantucket, Mass., 587; Wood's Holl Harbor, Mass., 591; Westport Harbor, Mass., 592; Wareham Harbor, Mass., 593; Taunton River, Mass., 595; Pawtucket River, R. I., 598; Providence River and Narragansett Bay, R. I., 602; Green Jacke, Shoal, Providence River, R. I., 605; Warren River, R. I., 605; Newport Harbor, R. I., 606; harbor of refuge at Block Island, R. I., 609; Little Narragansett Bay, R. I. and Conn., 613; harbor of refuge at Stonington, Conn., 614; Pawcatuck River, R. I. and Conn., 616; removing sunken vessels or craft obstructing or endangering navigation, 618.

APPENDIX D.

REPORT OF LIEUT. COL. D. C. HOUSTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Connecticut River, Mass. and Conn., 623; Thames River, Conn., 629; New London Harbor, Conn., 632; Clinton Harbor, Conn., 634; New Haven Harbor, Conn., 636; Breakwater at New Haven, Conn., 639; Milford Harbor, Conn., 640; Housatonic River, Conn., 642; Bridgeport Harbor, Conn., 644; Black Rock Harbor, Conn., 646; Southport Harbor, Conn., 648; Norwalk Harbor, Conn., 649; Port Chester Harbor, N. Y., 651; New Rochelle Harbor, N. Y., 654; Echo Harbor, New Rochelle, N. Y., 655; Mamaroneck harbor, N. Y., 657; Greenport Harbor, N. Y., 658; Port Jefferson Harbor, N. Y., 660; Flushing Bay, N. Y., 661; East Chester Creek, N. Y., 663.

APPENDIX E.

REPORT OF LIEUT. COL. WALTER McFARLAND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Hudson River, N. Y., 665; harbor at Saugerties, N. Y., 669; harbor at Rondout, N. Y., 670; Harlem River, N. Y., 672; removing obstructions in East River and Hell Gate, N. Y., 675; Newtown Creek, N. Y., 717; Buttermilk Channel, N. Y., 720; Gowanus Bay, N. Y., 722; Gedney's Channel, N. Y., 724; Sheepshead Bay, N. Y., 743; Canarsie Bay, N. Y., 746; Sumpawanus Inlet, N. Y., 748; Manasquan River, N. J., 751; Shrewsbury River, N. J., 756; harbor at Keyport, N. J., 760; Mattawan Creek, N. J., 761; Cheesequakes Creek, N. J., 763; Raritan Bay, N. J., 765; Raritan River, N. J., 769; South River, N. J., 777; Woodbridge Creek, N. J., 781; Rahway River, N. J., 783; Elizabeth River, N. J., 785; channel between Staten Island and New Jersey, 788; Passaic River, N. J., 792.

APPENDIX F.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River from Trenton, N. J., to its mouth, 801; Delaware River at Schooner Ledge, 828; Delaware River near Cherry Island Flats, 829; Frankford Creek, Pa., 829; Schuylkill River, Pa., 830; ice-harbor at Marcus Hook, Pa., 832; ice-harbor at the head of Delaware Bay, Del., 834; construction of iron pier in Delaware Bay near Lewes, Del., 836; Delaware Breakwater Harbor, Del., 839; Rancocas River, N. J., 841; Woodbury Creek, N. J., 843; Mantua Creek, N. J., 844; Raccoon River, N. J., 844; Salem River, N. J., 846; Cohansey Creek, N. J., 847; removal of wrecks from Delaware Bay and River, 847; removing sunken vessels or craft obstructing or endangering navigation, 848; United States commission advisory to the board of harbor commissioners of Philadelphia, Pa., 849.

APPENDIX G.

REPORT OF MR. WILLIAM F. SMITH, UNITED STATES AGENT.

IMPROVEMENTS.—Maurice River, N. J., 855; Wilmington Harbor, Del., 857; ice-harbor at New Castle, Del., 858; Duck Creek, Del., 859; Saint Jones River, Del., 860; Mispillion Creek, Del., 861; Broadkiln River, Del., 862; Broad Creek, Del., from its mouth to Laurel, 863; Indian River, Del., 864; Susquehanna River above and below Havre de Grace, Md., 864; Chester River at Kent Island Narrows, Md., 866; Chester River from Spray's Landing to Crumpton, Md., 866; Corsica Creek, Md., 867; Choptank River, Md., 868; Wicomico River, Md., 869; Upper Thoroughfare, between Deil's Island and the mainland, Md., 870.

APPENDIX H.

REPORT OF LIEUT. COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Patapsco River and channel to Baltimore, Md., 874; Annapolis Harbor, Md., 877; removing sunken vessels or craft obstructing or endangering navigation, 878.

APPENDIX I.

REPORT OF MAJ. PETER C. HAINS, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.

Improvements.—Harbors at Washington and Georgetown, D. C., 879; Potomac River at Washington, D. C., 881; James River, Va., 887; Shenandoah River, W. Va., 891.

APPENDIX J.

REPORT OF MR. S. T. ABERT, UNITED STATES AGENT.

Improvements.—Channel at Mount Vernon, Va., 899; Neabsco Creek, Va., 901; Breton Bay, Leonardtown, Md., 901; Nomini Creek, Va., 903; harbor at entrance of Saint Jerome's Creek, Md., 904; Rappahannock River, Va., 906; Totusky River, Va., 913; Urbana Creek, Va., 914; Mattaponi River, Va., 915; Pamunky River, Va., 917; York River, Va., 918; Chickahominy River, Va., 920; Staunton River, Va., 922 and 924; Dan River, between Madison, N. C., and Danville, Va., 925; Roanoke River, N. C. 927; French Broad River, N. C., 929.

Examination.—Aqueduct Bridge over the Potomac at Georgetown, D. C., 931.

APPENDIX K.

REPORT OF CAPT. F. A. HINMAN, CORPS OF ENGINEERS.

Improvements.—Harbor at Norfolk, Va., 951; Approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Va., 956; Appomattox River, Va., 958; Nottoway River, Va., 961; Blackwater River, Va., 961; Archer's Hope River, Va., 962; North Landing River, Va. and N. C., 962; Edenton Bay, N. C., 963; Currituck Sound, Coanjok Bay, and North River Bar, N. C., 965; Meherrin River, N. C., 965; Pamlico and Tar rivers, N. C., 966; Yadkin River, N. C., 967; Scuppernong River, N. C., 969; removing sunken vessels or craft obstructing or endangering navigation, 970.

APPENDIX L.

REPORT OF CAPT. WILLIAM H. BIXBY, CORPS OF ENGINEERS.

Improvements.—Contentnea Creek, N. C., 973; Trent River, N. C., 976; Neuse River, N. C., 979; inland navigation from New Berne to Beaufort Harbor, via Clubfoot, Harlowe, and Newport rivers, N. C., 983; harbor at Beaufort, N. C., 986; New River, N. C., 991; Cape Fear River, above Wilmington, N. C., 995; Cape Fear River, below Wilmington, N. C., 1000; Great Pe Dee River, S. C., 1017; Waccemaw River, S. C., 1022; harbor at Georgetown, S. C., 1027; Santee River, S. C., 1030; Wateree River, S. C., 1053; removing sunken vessels obstructing or endangering navigation, 1060.

APPENDIX M.

REPORT OF COL. Q. A. GILLMORE, CORPS OF ENGINEERS, BVT. MAJ. GEN., U. S. A.

Improvements.—Charleston Harbor, S. C., 1063; Wappoo Cut, S. C., 1077; Ashley River, S. C., 1080; Edisto River, S. C., 1082; Salkiehatchie River, S. C., 1084; Savannah Harbor and River, Ga., 1086; Savannah River, Ga., 1098; Savannah River above Augusta, Ga., 1100; Saint Augustine Creek (Thunderbolt River), Ga., 1102; Romerly Marsh, Ga., 1102; Altamaha River, Ga., 1105; Brunswick Harbor, Ga., 1112; entrance to Cumberland Sound, Ga. and Fla., 1118; inside passage between Fernandina and Saint John's River, Fla., 1124.

APPENDIX N.

REPORT OF LIEUT. WILLIAM M. BLACK, CORPS OF ENGINEERS.

IMPROVEMENTS.—Saint John's River, Fla., 1125; Upper Saint John's River, Fla., 1133; Volusia Bar, Fla., 1135; Tampa Bay, Fla., 1137; Apalachicola Bay, 1140; Suwanee River, Fla., 1143; Key West Harbor, Fla., 1144; Pease Creek, Fla., 1146; harbor at Cedar Keys, Fla., 1148; Manatee River, Fla., 1150; Caloosahatchie River, Fla., 1152; Apalachicola River, Fla., 1153; Withlacoochee River, Fla., 1155; removing sunken vessels or craft obstructing or endangering navigation, 1157.

APPENDIX O.

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ocmulgee River, Ga., 1159; Oconee River, Ga., 1161; Flint River, Ga., 1162; Oostenaula and Coosawattee rivers, Ga., 1165; Coosa River, Ga. and Ala., 1165; Chattahoochee River, Ga. and Ala., 1168; Alabama River, Ala., 1171; Tallapoosa River, Ala., 1172; Cahaba River, Ala., 1173; Conecuh—Escambia River, Fla. and Ala., 1175; Choctawhatchee River, Fla. and Ala., 1176; Bayou La Grange, Fla., 1178; harbor at Pensacola, Fla., 1179.

APPENDIX P.

REPORT OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mobile Harbor, Ala., 1183; Warrior and Tombigbee rivers, Ala. and Miss., 1193; Tombigbee River, 1196; Black Warrior River, from Tuscaloosa to Daniel's Creek, Ala., 1199; Old Town Creek, Miss., 1200; Noxubee River, Miss., 1201; Pascagoula River, Miss., 1203; harbor at Biloxi Bay, Miss., 1205; Horn Island Pass, Miss., 1206; Pearl River, Miss., below Jackson, 1207; Pearl River, Miss., from Jackson to Carthage, 1212; Pearl River, Miss., between Edinburg and Carthage, 1214.

EXAMINATIONS AND SURVEYS.—Pascagoula River, Miss., from the mills at Moss Point down to the anchorage in the bay, with a view to securing a uniform depth of 12 feet of water, 1215; Wacissa River, Fla., 1220.

APPENDIX Q.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

INSPECTION.—Improvement at the South Pass of the Mississippi River, 1225.

APPENDIX R.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Amite River, La., 1239; Tangipahoa River, La., 1241; Tchefuncte River, La., 1242; Tickfaw River, La., 1244; Bayou Teche, La., 1245; connecting Bayou Teche with Grand Lake at Charenton, La., 1259; Bayou Black, La., 1261; Bayou Courtableau, La., 1263; Bayou Terrebonne, La., 1264; Bayou La Fourche, La., 1266; Calcasieu River, La., 1276; Calcasieu Pass, La., 1277; Sabine Pass, Tex., 1278; Sabine River, La. and Tex., 1287; Neches River, Tex., 1288; removing sunken vessels or craft obstructing or endangering navigation, 1290.

APPENDIX S.

REPORT OF MAJ. S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1291; ship-channel in Galveston Bay, Tex., 1322; Trinity River, Tex., 1323; Buffalo Bayou, Tex., 1325; channel over the bar at the mouth of Brazos River, Tex., 1327; Pass Cavado Inlet to Matagorda Bay, Tex., 1328; Aransas Pass and Bay up to Rockport and Corpus Christi, Tex., 1330; harbor at Brazos Santiago, Tex., 1334; protection of river-bank at Fort Brown, Tex., 1336.

APPENDIX T.

REPORT OF CAPT. ERIC BERGLAND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Red River, La. and Ark., 1337; survey of Bayou Pierre, La., 1343; Cypress Bayou, Tex. and La., 1347; Cane River, La., 1349; Loggy Bayou, Lake Bisteneau and the Dorcheat, La., 1350; Ouachita and Black rivers, Ark. and La., 1351; Bayou Bartholomew, La. and Ark., 1353; Bayou Bœuf, La., 1354; Tensas River and Bayou Macon, La., 1355; Bayou D'Arbonne, La., 1356; Yazoo River, Miss., 1357; Big Sunflower River, Miss.. 1359; Tchula Lake, Miss., 1360; Tallahatchee River, Miss., 1361; Yallabusha River, Miss., 1362; Steele's Bayou, Miss., 1363; Big Black River, Miss., 1365; Big Hatchee River, Tenn., 1366; South Forked Deer River, Tenn., 1367; water-gauges on the Mississippi River and its principal tributaries, 1368.

APPENDIX U.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing obstructions in Arkansas River, Ark., 1371; Arkansas River at Pine Bluff, Ark., 1375; Black River, Ark. and Mo., 1377; White River, Ark., 1378; White River above Buffalo Shoals, Ark., 1381; Saint Francis River, 1382; Saline River, Ark., 1387; L'Anguille River, Ark., 1388.

SURVEYS.—Survey of Arkansas River, Ark., from Little Rock to its mouth, 1389; continuation of the survey of Arkansas River from Wichita, Kans., to Fort Gibson, Ind. T., 1391.

APPENDIX V.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing snags and wrecks from the Mississippi and Missouri rivers, 1393; Osage River, Kans. and Mo., 1395; Gasconade River, Mo., 1396.

APPENDIX W.

REPORT OF CAPT. JAMES B. QUINN, CORPS OF ENGINEERS.

IMPROVEMENT.—Yellowstone River, Mont. and Dak., 1399.

APPENDIX X.

REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Upper Mississippi River, operations of snag-boats and dredge-boats, 1403; Mississippi River from Saint Paul to Des Moines Rapids, 1412; Mississippi River from Des Moines Rapids to mouth of the Illinois River, 1422; harbor of refuge in Lake Pepin, at Stockholm, Wis., 1422; harbor of refuge in Lake Pepin, at Lake City, Minn., 1424; removal of bar in Mississippi River opposite Dubuque, Iowa, 1424; ice-harbor at Dubuque, Iowa, 1426; Rock Island Rapids, Mississippi River, 1427; Des Moines Rapids, Mississippi River, 1465; operating and care of Des Moines Rapids Canal, 1468; dry-dock at Des Moines Rapids Canal, 1477.

APPENDIX Y.

REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Preservation of Falls of Saint Anthony, Minn., 1479; Mississippi River above the Falls of Saint Anthony, Minn., 1483; construction of lock and dam on Mississippi River at Meeker's Island, Minn., 1485; Chippewa River, Wis., 1486; Chippewa River at Yellow Banks, Wis., 1488; Saint Croix River below Taylor's Falls, Minn. and Wis., 1490; Minnesota River, Minn., 1494; Red River of the North, Minn. and Dak., 1496; lock and dam at Goose Rapids on Red River of the North, Minn. and Dak., 1500; reservoirs upon the headwaters of the Mississippi River, 1501; surveys for reservoirs at the sources of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers, 1507.

APPENDIX Z.

REPORT OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River, 1509; Cumberland River, 1515; Hiawassee River, 1519; French Broad River, Tenn., 1520; Clinch River, Tenn., 1521; Duck River, Tenn., 1523; Caney Fork River, Tenn., 1523; Little Tennessee River, Tenn., 1524; South Fork Cumberland River, Ky., 1525.

APPENDIX A A.

REPORT OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINEERS, BVT. COL., U. S. A.

IMPROVEMENTS.—Ohio River, 1528; Operating and care of Davis Island Dam, Ohio River, 1540; Monongahela River, W. Va. and Penn., 1542; Operating and care of Lock and Dam No. 9, Monongahela River, 1543; Allegheny River, Pa., 1544; Dam at Herr's Island, Allegheny River, 1545; ice-harbor at mouth of Muskingum River, Ohio, 1546; Muskingum River, Ohio, 1547; operating and care of locks and dams on the Muskingum River, Ohio, 1548; harbor of refuge near Cincinnati, Ohio, 1549; harbor of refuge at mouth of Great Kanawha River, W. Va., 1550.

EXAMINATION AND SURVEY.—Muskingum River, Ohio, 1551.

APPENDIX B B.

REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River at Louisville, Ky., 1569; Indiana Chute, Falls of the Ohio River, 1572; Louisville and Portland Canal, 1574; Wabash River, Ind. and Ill., 1582; White River, Ind., 1586.

APPENDIX C C.

REPORT OF LIEUT. COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Great Kanawha River, W. Va., 1589; Elk River, W. Va., 1598; New River, from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbrier River, W. Va., 1599.

APPENDIX D D.

REPORT OF CAPT. JAMES C. POST, CORPS OF ENGINEERS.

IMPROVEMENTS.—Kentucky River, Ky., 1603; operating and keeping in repair locks and dams on the Kentucky River, Ky., 1610; Tradewater River, Ky., 1617; Big Sandy River, W. Va. and Ky., 1618; Guyandotte River, W. Va., 1622; Little Kanawha River, W. Va., 1623; Buckhannon River, W. Va., 1624.

APPENDIX E E.

REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Duluth, Minn., 1627; dredging Superior Bay, Wis., 1632; harbor at Grand Marais, Minn., 1637.

APPENDIX F F.

REPORT OF CAPT. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ontonagon Harbor, Mich., 1641: Eagle Harbor, Mich., 1643; Marquette, Harbor, Mich., 1645; harbor of refuge at Grand Marais, Mich., 1646; Manistique Harbor, Mich., 1649; harbor at mouth of Cedar River, Mich., 1650; Menomonee Harbor, Mich. and Wis., 1652; Oconto Harbor, Wis., 1653; Pensaukee Harbor, Wis., 1656; Green Bay Harbor, Wis., 1658; harbor of refuge at entrance of Sturgeon Bay Canal, Wis., 1660: Ahnepee Harbor, Wis., 1662; Kewaunee Harbor, Wis., 1663; Two Rivers Harbor, Wis., 1665; Manitowoc Harbor, Wis., 1667; Sheboygan Harbor, Wis., 1670; Port Washington Harbor, Wis., 1672.
SURVEY.—Ashland Harbor, in Ashland Bay, Lake Superior, 1674.

APPENDIX G G.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge, Milwaukee Bay, Wis., 1679; Milwaukee Harbor, Wis., 1680; Racine Harbor, Wis., 1682; Kenosha Harbor, Wis., 1684; Waukegan Harbor, Ill., 1685; Fox and Wisconsin rivers, Wis., 1686.

APPENDIX H H.

REPORT OF MAJ. W. H. H. BENYAURD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chicago Harbor, Ill., 1701; Calumet Harbor, Ill., 1704; Illinois River, 1705; Calumet River, 1707.
SURVEYS.—For Hennepin Canal, 1708.

APPENDIX I I.

REPORT OF CAPT. D. W. LOCKWOOD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Charlevoix Harbor, Mich., 1755; Frankfort Harbor, Mich., 1757; harbor of refuge at Portage Lake, Mich., 1758; Manistee Harbor, Mich., 1759; Ludington Harbor, Mich., 1761; Pentwater Harbor, Mich., 1762; White River Harbor, Mich., 1762; Muskegon Harbor, Mich., 1764; Grand Haven Harbor, Mich., 1766; Grand River, Mich., 1767; Black Lake Harbor, Mich., 1768; Saugatuck Harbor, Mich., 1769; South Haven Harbor, Mich., 1770; Saint Joseph Harbor, Mich., 1771; Michigan City Harbor, Ind., 1774.

APPENDIX J J.

REPORT OF LIEUT. COL. O. M. POE, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A.

IMPROVEMENTS.—Hay Lake Channel, Saint Mary's River, Mich., 1777; Saint Mary's Falls Canal and River, Mich., 1783; operating and care of Saint Mary's Falls Canal, Mich., 1809; dry-dock at Saint Mary's Falls Canal, Mich., 1823; harbor at Cheboygan, Mich., 1824; harbor at Thunder Bay, Mich., 1825; harbor at Au Sable, Mich., 1825; Saginaw River, Mich., 1826; harbor of refuge, Sand Beach, Lake Huron, Mich., 1829; steam launch or tug for harbor of refuge, Lake Huron, Mich., 1836; ice-harbor of refuge at Belle River, Mich., 1837; general repairs and renewals at Saint Clair Flats Ship Canal, Mich., 1837; operating and care of Saint Clair Flats Canal, Mich., 1838; Clinton River, Mich., 1842; Detroit River, Mich., 1842.

APPENDIX K K.

REPORT OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 1847; Toledo Harbor, Ohio, 1849; Port Clinton Harbor, Ohio, 1854; Sandusky City Harbor, Ohio, 1855; Sandusky River, Ohio, 1857; Huron Harbor, Ohio, 1858; Vermillion Harbor, Ohio, 1859; mouth of Black River, Ohio, 1861; Rocky River, Ohio, 1862; Cleveland Harbor, Ohio, 1863; Fairport Harbor, Ohio, 1868; Ashtabula Harbor, Ohio, 1871; Conneaut Harbor, Ohio, 1873; Dunkirk Harbor, N. Y., 1874; removing sunken vessels or craft obstructing or endangering navigation, 1876.

APPENDIX L L.

REPORT OF CAPT. EDWARD MAGUIRE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Erie Harbor, Pa., 1879; Buffalo Harbor, N. Y., 1881; Niagara River, N. Y., 1884; Wilson Harbor, N. Y., 1885; Olcott Harbor, N. Y., 1885; Oak Orchard Harbor, N. Y., 1886; Charlotte Harbor, N. Y., 1887; Pultneyville Harbor, N. Y., 1889; Great Sodus Harbor, N. Y., 1890; Little Sodus Harbor, N. Y., 1891; Oswego Harbor, N. Y., 1892; Sackett's Harbor, N. Y., 1894.

APPENDIX M M.

REPORT OF MAJ. M. B. ADAMS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ogdensburg Harbor, N. Y., 1895; Grass River at Massena, N. Y., 1898; Breakwater at Rouse's Point, Lake Champlain, N. Y., 1899; Swanton Harbor, Vt., 1901; Plattsburg Harbor, N. Y., 1902; Burlington Harbor, Vt., 1903; Otter Creek, Vt., 1905; Ticonderoga River, N. Y., 1905.

APPENDIX N N.

REPORT OF LIEUT. COL. G. H. MENDELL, CORPS OF ENGINEERS, BVT. COL., U. S. A.

IMPROVEMENTS.—Oakland Harbor, Cal., 1907; Wilmington Harbor, Cal., 1911; Redwood Harbor, Cal., 1914; removal of sunken vessels or craft obstructing or endangering navigation, 1915.

APPENDIX O O.

REPORT OF COL. C. SEAFORTH STEWART, CORPS OF ENGINEERS.

IMPROVEMENT.—Harbor at San Diego, Cal., 1917.

APPENDIX P P.

REPORT OF CAPT. A. H. PAYSON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Humboldt Harbor and Bay, Cal., 1919; San Joaquin River, Stockton and Mormon sloughs, Cal., 1921; Mokelumne River, Cal., 1924; Sacramento and Feather rivers, Cal., 1926; Colorado River, Nev., Cal., and Ariz., 1929.

APPENDIX Q Q.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Columbia and Willamette rivers below Portland, Oreg., 1938; Upper Willamette River, Oreg., 1940; Columbia River at Cascades, Oreg., 1942; Upper Columbia and Snake rivers, Oreg. and Wash., 1949; Cowlitz River, Wash. 1952; Lower Clearwater River, Idaho, 1952.

EXAMINATIONS AND SURVEYS.—Columbia River above mouth of Snake River, Wash., 1953; Columbia and Snake rivers, 1970.

APPENDIX R R.

REPORT OF CAPT. CHARLES F. POWELL, CORPS OF ENGINEERS.

Improvements.—Mouth of the Columbia River, Oreg. and Wash., 1972; entrance to Coos Bay, Oreg., 1989; entrance to Yaquina Bay, Oreg., 1998; mouth of Coquille River, Oreg., 2003; Umpqua River, Oreg., 2005; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., 2007; Chehalis River, Wash., 2009; gauging waters of the Columbia River and principal tributaries, 2010.

APPENDIX S S.

REPORT OF MAJ. G. J. LYDECKER, CORPS OF ENGINEERS.

Improvements.—Washington Aqueduct, 2013; increasing the water supply of the city of Washington, 2043; erection of fish-ways at the Great Falls of the Potomac River, 2061.

APPENDIX T T.

REPORT OF COL. JOHN M. WILSON, U. S. A.

Improvement and care of public buildings and grounds in the District of Columbia, 2075.

APPENDIX U U.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Bridge across the Mississippi River at Keithsburg, in the State of Illinois, 2111; stone-arch bridge across the West Channel of the Mississippi River at Minneapolis, Minn., 2111; proposed bridge across the Ohio River at or near Cairo, Ill., 2116; bridge of the Selma Bridge Company across the Alabama River at Selma, Ala., 2136; changes in the original plan of the bridge across the Ohio River at Henderson Ky., 2137.

APPENDIX V V.

SUPPLEMENTAL REPORT OF THE MISSISSIPPI RIVER COMMISSION, 2143.

Q. A. Gillmore, Col. of Engineers, Bvt. Maj. Gen., U. S. A., *President.*
C. B. Comstock, Lieut. Col. of Engineers, Bvt. Brig. Gen., U. S. A.,
Charles R. Suter, Major of Engineers, U. S. A.,
Mr. Henry Mitchell, Coast and Geodetic Survey,
Mr. B. M. Harrod, Civil Engineer,
Mr. S. W. Ferguson, Civil Engineer,
Mr. Robert S. Taylor,
Commissioners.

APPENDIX W W.

SUPPLEMENTARY REPORT OF THE MISSOURI RIVER COMMISSION, 2167.

Charles R. Suter, Major of Engineers, U. S. A., *President.*
Alex. Mackenzie, Major of Engineers,
O. H. Ernst, Major of Engineers,
Mr. G. C. Broadhead,
Mr. William J. Broatch,
Commissioners.

ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY.

1886.

REPORT

OF

THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 28, 1886.

SIR: I have the honor to present for your information the following report upon the duties and operations of the Engineer Department for the fiscal year ending June 30, 1886:

OFFICERS OF THE CORPS OF ENGINEERS.

The number of officers holding commissions in the Corps of Engineers, United States Army, at the end of the fiscal year was 108 on the active list, two of whom were graduates of the Military Academy and commissioned second lieutenants, Corps of Engineers, to date June 14, 1885, and eight on the retired list; the latter, however, under section 1259 Revised Statutes, not being available for duty.

Since the last annual report the Corps has lost by death one of its officers, Capt. Thomas N. Bailey, who died at Willets Point, N. Y., April 20, 1886.

On the 30th of June, 1886, the officers were distributed as follows:

Office Chief of Engineers, including the Chief	3
Office Chief of Engineers and Public Buildings and Grounds	1
Fortifications and river and harbor works	14
Fortifications, river and harbor works, Board of Engineers, and Board of Visitors at Engineer School of Application	1
Fortifications and Battalion of Engineers	1
Fortifications, river and harbor works, and light-house duty	2
Fortifications, river and harbor works, Board of Visitors at Engineer School of Application, and Mississippi River Commission	1
Fortifications, river and harbor works, and supervising engineer	2
River and harbor works	30
River and harbor works and light-house duty	3
River and harbor works and Missouri River Commission	2
Mississippi River Commission, Missouri River Commission, and light-house duty.	1
Board of Engineers, Board of Visitors at Engineer School of Application, Mississippi River Commission, supervising engineer, Post of Willets Point, and Engineer School of Application	1
Board of Engineers, Board of Visitors at Engineer School of Application, and light-house duty	1
Board of Engineers and Board of Visitors at Engineer School of Application	1
Supervising engineer	1
Publications of geological surveys west of the one hundredth meridian	1

Washington Aqueduct	1
Battalion of Engineers	15
Leave of absence	3
Detached, on duty with generals commanding divisions and departments, Light-House Establishment, Military Academy, Board of Commissioners of the District of Columbia, the Mississippi River and Missouri River Commissions, and construction of building for State, War, and Navy Departments, &c	23
	108

The officers detached were on duty as follows:

Col. Thomas L. Casey, in charge of the construction of the building for the State, War, and Navy Departments; of the Washington National Monument; of the improvements over the grave of Thomas Jefferson, at Monticello, Va.; of the erection of a pedestal and statue of the late President Garfield; of a monument at Washington's Headquarters at Newburgh, N. Y.; of the erection of a monument to mark the birthplace of George Washington, and of the erection of building for the Army Medical Museum and Library; member of Advisory Board to Committee on Ventilation and Acoustics of the House of Representatives; member of the Light-House Board	1
Maj. David P. Heap, engineer secretary to the Light-House Board	1
Maj. William Ludlow, Engineer Commissioner of the District of Columbia	1
Maj. William S. Stanton, engineer first and second light-house districts	1
Maj. Thomas H. Handbury, on staff of Commanding General, Division of the Missouri	1
Capt. James F. Gregory, engineer fifth and sixth light-house districts	1
Capt. John C. Mallery, engineer fourth light-house district	1
Capt. Thomas Turtle, secretary and disbursing officer of the Mississippi River Commission	1
Capts. Frederick A. Mahan and Thomas W. Symons, and Lieut. Eugene Griffin, assistants to Engineer Commissioner of District of Columbia	3
Capt. Philip M. Price and Lieut. James G. Warren, on duty with Company E, Battalion of Engineers, and at Military Academy	2
Capt. Dan C. Kingman, on staff of Commanding General, Department of the Platte.	1
Lieuts. Walter L. Fisk, Gustav J. Fieberger, and George W. Goethals, on duty at Military Academy	3
Lieut. Thomas L. Casey, on staff of Commanding General, Division of the Pacific and Department of California	1
Lieut. Theodore A. Bingham, secretary and disbursing officer of The Missouri River Commission	1
Lieut. John Millis, on duty under the immediate orders of Colonel Duane as his assistant in connection with experiments upon electric lighting	1
Lieut. John Biddle, on staff of Commanding General, Department of Dakota	1
Lieut. Edward Burr, on staff of Commanding General, Department of the Columbia	1
Lieut. Eugene J. Spencer, on staff of Commanding General, Department of Arizona.	1
	23

SEA-COAST AND LAKE-FRONTIER DEFENSES.

During the year operations have been restricted to those necessary for the preservation and repair of existing works.

The subject of the defensive system of the country, so far as regards the ports at which fortifications or other defenses are most urgently required, has received the careful consideration of a Board of distinguished officers and civilians, of which the Secretary of War was President, and that Board has submitted an elaborate and complete report to Congress, showing the utterly defenseless condition of our sea-coast and lake frontier.

It is believed that the failure of Congress to make appropriations for this all-important work has mainly arisen from the difficulty in determining the best method of procuring armor-plate.

The preparation of the sites, the construction of masonry foundations, the building of mortar batteries, work equally as necessary as that of procuring armor, will demand much time, and it is earnestly recommended that funds be at once appropriated for the emplacements of turrets and casements, for earthen batteries, for 12-inch rifled mortars, and for submarine mines, all of which can be accomplished before armor-plate is required.

The estimates now submitted are based upon the present defensive system of our coasts, the amount estimated for preservation and repair of fortifications being required to prevent such modern batteries as we now have from going to ruin, and to maintain old works, many of which can now only be considered as relics of an historic past.

For fuller and more detailed estimates for the important work of constructing a complete system of defensive works for the more important harbors on our coast, I respectfully invite attention to report of the Board on Fortifications or other Defenses, to which I have already referred. (See Appendix No. 3.)

Attention is invited to the estimates for torpedoes. For the present our principal reliance for harbor defense in case of war must rest upon fixed mines, and it is very necessary that there should be a full supply of these on hand at the principal sea-ports of the nation.

Owing to the failure of Congress to make appropriations either for fortifications or torpedoes for the present fiscal year, it has become necessary not only to suspend torpedo experiments, but also to a great extent the practical instruction of the engineer troops in the details of this service. These experiments have been in progress for some years, and a system of fixed mines has been developed and gradually improved until it bids fair before long, if funds are available, to reach the highest point of excellence.

ESTIMATES OF APPROPRIATIONS REQUIRED FOR 1887–'88.

For acquisition of sites of two martello towers at Key West, Fla., by purchase or condemnation	$9,000
For purchase of additional land at Fort Hamilton, N. Y	180,000
For protecting site of Fort Niagara, N. Y	20,000
For sea-wall at Governor's Island, New York Harbor	50,000
For sea-wall at David's Island, New York Harbor	35,000
For earth embankment at David's Island, New York Harbor	12,000
Fort Marion, Florida:	
For restoration of the old fort to the condition, substantially, in which it was left by the Spaniards	10,000
For protection, preservation, and repair of fortifications for which there may be no special appropriation available	175,000
For purchase of submarine mines and necessary appliances to operate them for closing the channels leading to our principal sea-ports	300,000
For needful casemates, cable galleries, &c., to render it possible to operate submarine mines	200,000
For continuing torpedo experiments, and for practical instruction of Engineer troops in the details of service	30,000
For torpedo-shed at San Francisco Harbor	22,000
Total	1,043,000

DEFENSES OF THE NORTHERN FRONTIER.

Fort Wayne, Michigan, in charge of Lieut. Col. O. M. Poe, Corps of Engineers.—This work is situated on the west bank of Detroit River, adjacent to the city of Detroit, and is intended to command the channel of the river.

It is a nearly square bastioned work, with brick and concrete scarp, semi-detached on curtains and faces, and unfinished water batteries on the up-stream and down-stream sides.

The construction of the fort in its present form was begun in 1862 and completed in 1871.

Since the last annual report work has been confined to repairing 13 gun-platforms and the demilune magazine. The work was done by hired labor.

No estimate of funds required to complete the work is submitted.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Fort Porter, Black Rock, near Buffalo, New York, in charge of Capt. Edward Maguire, Corps of Engineers.—This work, commenced in 1842, is situated on the Niagara River, within the limits of the city of Buffalo, and consists of a square stone tower or keep, in ruins, surrounded by a square barbette battery.

The keep was nearly destroyed by fire many years ago, and the entire work is, in its present condition, useless for offense or defense.

By joint resolution of Congress, approved July 11, 1870, published in General Orders 93, July 22, 1870, permission was granted to the city of Buffalo, through its park commissioners, "to improve and beautify the grounds known as Fort Porter, situated in said city, and belonging to the United States, in connection with a public park to be laid out on land adjoining the said grounds, the plans for the same to be approved by the Secretary of War: *Provided*, That this resolution shall not be construed to pass any title in the said grounds, but that the ownership and control of said grounds shall remain entirely in the United States, and shall be subject to such changes and uses for military purposes as the Secretary of War may direct."

Under date of April 12, 1884, the Secretary of War granted permission to the park commissioners to construct a roadway through the reservation, cutting the rampart of the fort.

Under the above-mentioned authorities the larger part of the United States grounds has been handsomely laid out and improved by the city of Buffalo. The roadway was constructed, necessitating the tearing down of the west angle, including the hot-shot furnace and the river face. Along this face a wooden fence was erected.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Fort Niagara, mouth of Niagara River, New York, in charge of Capt. Edward Maguire, Corps of Engineers.—This work, commenced in 1839, is situated at the mouth of the Niagara River, on the south shore of Lake Ontario, about 40 miles from, and east of, its western extremity.

It is an irregular work, having one strong land front running nearly north and south, extending from Lake Ontario at its northern extremity nearly to the Niagara River at its southern extremity. This front is half bastioned, with detached parapet, demilune, and four casemates for howitzers in each flank. The rest of the *tracé* is irregular, following the general course of the river and of the lake shore.

The work contains two masonry block-houses, built by the French about 1757, and other buildings begun by the French and finished by the English after its capture by them during the French and Indian war.

DEFENSES OF THE NORTHERN FRONTIER—continued.

No money has been expended on this work since 1871, except for slight repairs.

No appropriation was made for the fiscal year ending June 30, 1887.
Appropriation asked for next fiscal year for protection of site of work $20,000

Fort Ontario, mouth of Oswego River, New York, in charge of Capt. Edward Maguire, Corps of Engineers.—This work is situated at the mouth of the Oswego River, on its east bank, and on the south shore of Lake Ontario, and lies within the limits of the city of Oswego.

The work was commenced in 1839 and continued at intervals until 1872, at which time constructive operations ceased; since which expenditures have been limited to minor repairs. Its condition is essentially the same as stated in the Annual Report for 1885. The fort was regarrisoned in the spring of 1884.

During the fiscal year the ditch-drains on Fronts Nos. I and II were cleaned and repaired; a new roof was built on the Engineer store-house, and the revetment in rear of the officers' quarters and around the magazine area was repaired.

In other respects no changes have taken place in the work since last reported upon.

During the year no change has been made in the armament of this work, or in its condition to receive armament.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Fort Montgomery, outlet to Lake Champlain, New York, in charge of Maj. M. B. Adams, Corps of Engineers.—This casemated work is situated on the west shore of the outlet to Lake Champlain, about one-third of a mile from the Canadian boundary, and occupies a strategic point of great importance, and commands the entrance to Lake Champlain from the Richelieu or Saint John River.

This work was commenced in 1841, and its rebuilding in its present form was accomplished in 1876, and completes the work, except the interior fittings of a part of the casements intended for quarters, and also parts of Bastions A and E, where temporary woooden floors have been built for the second tier of casements.

During the fiscal year ending June 30, 1886, operations at this work have been confined to the repairs of five center pintle and six front pintle platforms, and the renewal of the wood-work of the bridge over the moat.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

SEA-COAST DEFENSES.

DEFENSES OF THE PENOBSCOT.

Fort Knox, Bucksport, Penobscot River, Maine, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This work, situated at the narrows of the Penobscot River, furnishes a defense for the city of Bangor, 18 miles above, and other towns bordering the river, and renders it available as a secure harbor of refuge for the shipping of the extensive eastern coast.

DEFENSES OF THE PENOBSCOT—continued.

This work was commenced in 1844, and in 1869 was completed according to the design save a few minor matters like the interior finish of casement quarters.

During the past year the grading of the parade inside the main work was completed. No other work of construction has been carried on, and the only other expenditures have been such as were incidental to the care and preservation of buildings and public property.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF THE KENNEBEC.

Fort Popham, Kennebec River, Maine, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This is a granite work situated upon Hunnewell's Point, on the west side of the mouth of the Kennebec River. It is intended to prevent the entrance of hostile vessels into the Kennebec River, and thus forms a refuge for our own vessels in the waters above. The defense of the river contributes to the protection of the State capital and the arsenal at Augusta, and to towns below on the river having some commercial and ship-building importance. It also aids in the defense of various points of strategic value.

A small fortification of old design formerly occupied the extreme end of the point. The present work was commenced in 1862, and continued until the close of the season of 1867, when active operations were suspended. No work of construction was carried on during the last fiscal year, except such as were required for the necessary care and for the preservation, of public property.

Some additions and changes to the work have been devised and approved, but extensive modifications are still required. No further operations are proposed until these modifications are complete.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF PORTLAND.

Fort Gorges, Portland Harbor, Maine, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This casemated work, commenced in 1857, is one of the series of forts designed to defend the harbor and channels leading into the harbor of the important strategic position occupied by the city of Portland. Its construction was suspended for want of funds in 1876, and the work is in an incomplete condition.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Preble, Portland Harbor, Maine, in charge of Col. C. E. Blunt, Corps of Engineers, until February, 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This work occupies a position on Spring Point, in such position that nearly all its guns bear upon the

DEFENSES OF PORTLAND—continued.

two principal channels leading to the anchorage and harbor. The latest additions to the work were commenced in 1863, and work thereon was suspended in 1867. The original work on this site was built in 1808.

In the last year two magazines have received the interior finish in the north battery; two service magazines have been similarly finished in the redoubt and eight magazines also completed in the south battery. All the magazines in the work are now in serviceable condition.

With the exception of the finished magazines, the work is in the same condition as indicated in the last annual report.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Scammel, Portland Harbor, Maine, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; since that date in charge of Maj. Jared A. Smith, Corps of Engineers.—This work occupies a very important position in the harbor, and commands four of the channels leading into it.

The original work on this site (House Island), built about 1808, consisted of a semi-circular battery, with brick scarp and block-house in rear, and a detached lunette northeast of it. About 1845 the works were connected so as to form one inclosed work, with brick scarp and earthen parapet.

In 1862 the execution of the new plans was commenced, and (with some subsequent modifications in 1870) the work was carried on till the close of the season of 1875, when it was suspended for want of funds.

It is an inclosed work, with detached masonry bastions and heavy earthen batteries.

Plans for its modification and for additional earthen batteries have been prepared by the Board of Engineers for Fortifications and approved by the Secretary of War. They are only partially executed, and the work is in an incomplete condition. The plans require revision.

During the last fiscal year six magazines were put in serviceable order. No other work has been done, and no other expenditures have been made save such as were necessary for the care and preservation of the buildings and public property.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Battery on Portland Head, Portland Harbor, Maine, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; since that date in charge of Maj. Jared A. Smith, Corps of Engineers.—This earthwork, commenced in 1873, will, when completed, cover by its guns all the approaches to the main channel leading into the harbor, and will prevent by its fire an enemy's fleet from taking up, unopposed, a position behind Cushing's Island from which to shell the shipping in the harbor.

This work remains in the incomplete condition reported at the close of the last fiscal year.

DEFENSES OF PORTLAND—continued.

For the construction of the operating-room and gallery for torpedo cables an appropriation is asked under the general appropriation for cables, galleries, &c.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Batteries on Cow Island, approaches to the harbor of Portland, Maine.—The object of these earthworks is, with batteries designed to be placed on Great Hog Island, to prevent an enemy's occupation of Casco Bay and to guard the passage from it to Portland Harbor.

Plans for the construction of batteries for the heaviest guns on this island have been prepared by the Board of Engineers for Fortifications, and it is proposed to commence work upon them as soon as funds are available. The plans require revision.

No appropriation for their construction has yet been made.
No appropriation asked for next fiscal year.

Batteries on Great Hog Island, approaches to the harbor of Portland, Maine.—The object of these earthworks is, with batteries designed to be placed on Cow Island, to prevent an enemy's occupation of Casco Bay and to guard the passages from it to Portland Harbor.

Plans for the construction of batteries for the heaviest guns on this island have been prepared by the Board of Engineers for Fortifications, and it is proposed to commence work upon them as soon as funds are available. The plans require revision.

No appropriation for their construction has yet been made.
No appropriation asked for next fiscal year.

Fort McClary, Portsmouth Harbor, New Hampshire, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This work, together with Fort Constitution, opposite, forms the inner line of defense to the mouth of the Piscataqua River and to the navy-yard at Kittery, Me.

The defenses of the mouth of the Piscataqua perform an important part in protecting the interior from invasion, as navigation above crosses two through lines of railroad and reaches the city of Dover, N. H., and numerous small places.

The original fort was commenced early in the present century. An inclosed barbette work was commenced in 1863, but has not been completed.

The work remains the same as at the date of last report, no operations having been carried on except for the necessary care and preservation of the property.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Fort Constitution, Portsmouth Harbor, New Hampshire, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This work, together with Fort McClary, opposite, forms the inner line of defense

DEFENSES OF PORTLAND—continued.

to the mouth of the Piscataqua River and to the navy-yard at Kittery, Me.

Extensive modifications are required for the casemated work at this place before proceeding with its construction. Plans for an exterior earthen battery for heavy rifled guns have been approved by the Secretary of War, but it has not yet been commenced. The plans require revision.

The condition of this work has remained unchanged since the date of the last annual report, no operations having been carried on except for the necessary care and preservation of the property.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Battery on Gerrish's Island, Portsmouth Harbor, New Hampshire, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This earthwork, with the one opposite, on Jerry's Point, forms the outer line of defense to Portsmouth Harbor and to the navy-yard at Kittery, Me. It was commenced in 1873.

The work remains in the same incomplete condition reported at the close of the last fiscal year.

Plans for the completion of this work have been prepared by the Board of Engineers for Fortifications and approved by the Secretary of War, but are only partially executed. The plans require revision.

An appropriation for constructing the operating-room and gallery for torpedo cables is asked under the general appropriation for cable galleries, &c.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Battery on Jerry's Point, Portsmouth Harbor, New Hampshire, in charge of Col. C. E. Blunt, Corps of Engineers, until February 28, 1886; *since that date in charge of Maj. Jared A. Smith, Corps of Engineers.*—This earthwork is on the western side of the entrance to the harbor of Portsmouth, N. H., and with the battery at Gerrish's Island, on the opposite side of the entrance, forms the outer line of defense to that harbor and to the navy-yard at Kittery, Me. It was commenced in 1873.

During the last year the five magazines at the battery were finished inside and placed in serviceable order. The earthwork of the battery is still incomplete.

The platforms are ready to receive the 15-inch guns for which they were designed.

Plans for the completion of this work have been prepared by the Board of Engineers for Fortifications and approved by the Secretary of War, but are only partially executed. The plans require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF BOSTON AND THE NAVY-YARD AT CHARLESTOWN.

Fort Warren, Boston Harbor, Massachusetts, in charge of Maj. Charles W. Raymond, Corps of Engineers, until February 4, 1886; *since that date in charge of Maj. George L. Gillespie, Corps of Engineers.*—This fort, situated on George's Island, commands the main ship-channel and the anchorage of Nantasket Roads. It consists of a granite, casemated, full-bastioned *enceinte*, with an earthen cover-face and ravelin.

It was commenced in 1833, and its plans have been modified by the Board of Engineers for Fortifications to adapt it for modern ordnance. These modified plans were partly executed when operations were suspended in 1875–'76 for want of appropriations.

During the fiscal year operations have been confined to the following:

The cisterns, eleven in number, under the casemates of Front III were repaired. The old plastering was removed and new substituted.

Fourteen doors were built and hung at the entrances of the service magazines.

Extra traverse irons were placed on all of the 10-inch-gun front pintle barbette platforms (181 in number), to adapt them to the new ordnance carriage for 8-inch converted rifles.

A new wooden latrine, 8 by 20 feet in plan, was built on the sea-wall near bastion A, for the use of the garrison and Engineer laborers.

The hull and machinery of the steamer Tourist were repaired.

The estimated amount required to complete the work is $185,000. The plans require revision.

No appropriation asked for next fiscal year.

Battery at Long Island Head, Boston Harbor, Massachusetts, in charge of Maj. Charles W. Raymond, Corps of Engineers, until February 4, 1886; *since that date in charge of Maj. George L. Gillespie, Corps of Engineers.*—This earthwork occupies an important position in the outer line of defense for Boston Harbor, and its guns bear on all the channels of entrance.

It was commenced in 1871, and was designed for the reception of the heaviest modern ordnance. Nothing has been done in construction since the fiscal year 1875–'76 for want of appropriations, and the work, the plans of which have been prepared by the Board of Engineers for Fortifications and approved by the Secretary of War, is in an unfinished condition.

During the fiscal year ending June 30, 1886, operations have been limited to the following:

Nine doors were built and hung at the entrances of the parados arch.

The iron-work of the new 15-inch gun platforms was scraped and painted.

The earth slopes of the traverse magazines and parados were partly repaired.

Some minor repairs were made to the store-house.

To complete the work in accordance with existing plans it is estimated that $90,000 will be required. The plans require revision.

No appropriation asked for next fiscal year.

Fort Winthrop, Boston Harbor, Massachusetts, in charge of Maj. Charles W. Raymond, Corps of Engineers, until February 4, 1886; *since that date in charge of Maj. George L. Gillespie, Corps of Engineers.*—This fort is situated on Governor's Island; it forms part of the inner line of defense for Boston Harbor and the Charlestown navy-yard.

DEFENSES OF BOSTON AND THE NAVY-YARD AT CHARLESTOWN—continued.

It was commenced in 1844, and consists of a central casemated tower, with outlying earthen barbette batteries.

The batteries were modified by the Board of Engineers for Fortifications for the reception of modern ordnance, and their plans have been partly executed, although no active operations have been in progress since 1875–'76, for want of funds.

During the fiscal year ending June 30, 1886, operations have been limited to the following:

Twenty doors were built and hung at the entrances of the service magazines of the south, the east, and the mortar batteries.

The iron work of the new 15-inch gun platforms was scraped and painted.

The 10-inch gun platforms (twenty-six in number) were provided with extra traverse irons, to adapt them to the new ordnance carriage for 8-inch converted rifles.

The entrance door of the tower was built and hung.

The main drain of the tower was cleaned out and extended to the northwest salient by a line of 6-inch drain-pipe from the northeast salient running through the center of the ditch.

The work is essentially in as good order as at the date of the last annual report.

The estimated amount to complete the work in accordance with existing plans is $180,000.

The plans of the batteries require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Independence, Boston Harbor, Massachusetts, in charge of Maj. Charles W. Raymond, Corps of Engineers, until February 4, 1886; since that date in charge of Maj. George L. Gillespie, Corps of Engineers.—This work is situated on Castle Island, and forms part of the inner line of defense for Boston Harbor and the navy-yard at Charlestown. It was commenced in 1833, and consists of a granite casemated *enceinte*, with two exterior earthen barbette batteries.

The plans of this work were modified by the Board of Engineers for Fortifications for the reception of modern ordnance, and these plans have been well advanced towards completion, although active operations have been suspended since 1875–'76 from want of appropriations.

During the fiscal year ending June 30, 1886, operations have been limited to the following:

Eleven doors were built and hung at the entrances of the service magazines of the *enceinte* and east exterior battery.

The iron-work of the new 15-inch gun platforms was scraped and painted.

The seven front pintle 10-inch gun platforms of the *enceinte* had each an extra traverse iron placed on them to adapt them to the new ordnance carriage for 8-inch converted rifles.

The work is in as good order as at date of last report.

DEFENSES OF BOSTON AND THE NAVY-YARD AT CHARLESTOWN—continued.

The estimated amount necessary to complete the work in accordance with the present plans is $50,000.

The plans require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

DEFENSES OF NEW BEDFORD.

Fort at Clark's Point, New Bedford Harbor, Massachusetts, in charge of Lieut. Col. George H. Elliot, Corps of Engineers.—This casemated work, commenced in 1857, commands the entrance to the harbor of New Bedford.

Plans for new earthen batteries for modern heavy guns have been completed by the Board of Engineers for Fortifications, but nothing has been done towards their construction. The plans require revision.

The operations of the past fiscal year, which were confined to works of repair and preservation, were as follows: The large dwelling house acquired with the fort lands, and since used for office and other purposes, was shored up and shingled to save it from further damage. One of the casemates was fitted up for a store-room for Engineer property at the fort, a portion of the floor of the iron balcony in the main work, destroyed in a gale in the winter of 1885–'86, was relaid. Repairs were made to the fort-keeper's house, which was also repainted; to one of the magazine doors, and to the bridge at the sallyport, and the approach to the latter was graded.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

DEFENSES OF NARRAGANSETT BAY.

Fort Adams, Newport Harbor, Rhode Island, in charge of Lieut. Col. George H. Elliot, Corps of Engineers.—This large and important work, commenced in 1824, defends the harbor and city of Newport, and commands the principal passage to Narragansett Bay, one of the best roadsteads on the coast.

The preparatory work for the construction of the new exterior earthen battery for modern ordnance (such as opening roads, draining the grounds, &c.) having been all completed, rapid progress can be made in construction when the necessary funds are appropriated. This important battery at the end of the fiscal year 1875–'76 had but recently been commenced in accordance with plans approved by the Secretary of War, and no work has been done since that year for want of appropriations. The plan of this battery requires revision.

The operations of the last fiscal year were as follows: The iron-work of four front pintle platforms for 15-inch or heavy rifled guns was completed, and two magazines for the service of these guns were floored and fitted with heavy oak and with ventilating doors. The cement

DEFENSES OF NARRAGANSETT BAY—continued.

house was reshingled. A strong stone jetty containing one of the main sewers of the fort was carried out into the sea on the west front far enough to drop the sewage into the tide-way. A masonry sewer-trap-basin was built in the demilune of the east front. The interiors of the newly-fitted magazines were whitewashed; the iron-work of the new gun platforms was painted, and the traverse rails in casemates were scraped and painted. The new sea-wall for the protection of the east shore was extended 304 feet, and repairs were made to some of the old sea-walls. The south retaining-wall at cut for road through the north demilune was rebuilt. The upper part of the old breast-high wall on the land front of the main work, which had become unserviceable as a revetment, was rebuilt for the entire length of this wall, 812 feet, except a distance of about 90 feet, where the mortar is so much decayed that the main wall will have to be rebuilt. The work of concreting the surface of the terreplein of the main work, 74,586 square feet in all, was completed by the covering of 5,743 square feet during the fiscal year.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Defenses of Dutch Island, Narragansett Bay, Rhode Island, in charge of Lieut. Col. George H. Elliot, Corps of Engineers.—The earthen batteries on this island, commenced in 1863, command the western entrance to Narragansett Bay. Nothing has been done in the construction of the defenses since the fiscal year 1875–'76. They are incomplete, and the plans require revision.

The operations of the past fiscal year were as follows: Laying the iron-work of one center pintle and four front pintle 15-inch or heavy rifled guns, and fitting up of two magazines for their service by laying floors and providing the necessary oak and ventilating doors; storing the large quantity of portable railroad track belonging to the work; small repairs to wharves and public buildings, and painting the iron-work of gun platforms.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF NEW LONDON HARBOR AND NAVY-YARD.

Fort Trumbull, New London Harbor, Connecticut, in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—Fort Trumbull is situated on a promontory on the west shore of New London Harbor, about 2 miles from Long Island Sound; the reservation contains about 13.9 acres, and has over 2,000 feet water-front, with a small wharf near the northern extremity.

The fortifications consist of—

1. A pentagonal, masonry, bastioned, casemated work of one tier, with a barbette battery on top, having three water-fronts and four bastions, the bastion at the junction of the two land-fronts being omitted. This

work was built in 1838–1848. The casemates furnish positions for fourteen heavy guns and eight flank howitzers, and the barbette for twenty-four heavy guns.

The northern land front, through which the sallyport passes, is protected by a cover-face arranged with a place of arms and positions for six barbette guns.

2. A south exterior water battery which mounts six 8-inch Rodman guns and two 100-pound Parrotts.

3. A north exterior earthen battery, built in 1874–'76, arranged for mounting five 15-inch guns in single position to command the channel. The platforms for these guns are completed, with the exception of the traverse irons, which are on hand and ready to be laid.

A plan of the Board of Engineers for rebuilding the south exterior battery and fitting it for five 15-inch Rodmans in single position was approved in 1874, but no money has yet been applied to carrying out the project.

During the past year no work, either of construction or repair, has been done at this fort. It is now in good condition, with the exception of some of the brick facing of the casemates, which has been damaged by leakage through the covering of the arches or between the arches and the scarp-wall.

The alteration of the south water battery, as planned by the Board of Engineers, to fit it for the use of 15-inch Rodmans, is necessary to the proper defense of the position.

Fort Trumbull is garrisoned by two companies of the First Artillery.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Griswold, New London Harbor, Connecticut, in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—This is an open barbette earthwork, on the east side of New London Harbor, opposite the city of New London. It was begun in 1840, as an auxiliary to Fort Trumbull, and from its commanding position on Groton heights, 80 feet above the sea, it overlooks every part of the harbor. It has positions for sixteen guns, eleven 10-inch Rodmans and five 8-inch Rodmans; but under an approved plan of the Board of Engineers this battery is to be fitted for eight 15-inch Rodmans, the estimated cost of which is $48,000.

The reservation contains about 12.8 acres; its site is mainly on the high east bank of the Thames River, back of the village of Groton; it includes a roadway extending to the river, with about 66 feet of water front.

No money has ever been appropriated for the modification of this battery, and no work upon it has been done.

No work has been done upon it during the past year, and it is now in very good condition.

There is no garrison at Fort Griswold, an ordnance sergeant being left in charge of it.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF NEW HAVEN.

Fort Hale, New Haven, Connecticut, in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—This is an earthwork built near the close of the rebellion, situated on a low point on the east shore of the harbor, about 2 miles below the city. It is a temporary work, and is rapidly falling down. Its site is valuable in a military sense only for a small work, to be used against small vessels that might enter the harbor. The area of the reservation is about 30 acres; it has 2,300 feet of water front.

No project for rebuilding it has ever been made.

No work has been done upon it in the last year, and no appropriation is asked for the next fiscal year.

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN.

Fort Schuyler, East River, New York, in charge of Lieut. Col. H. L. Abbot, Corps of Engineers, until May 24, 1886; *since that date in charge of Lieut. Col. C. B. Comstock, Corps of Engineers.*—This work and the opposite fort at Willets Point are our only dependence for closing the harbor of New York City against attack from the direction of Long Island Sound.

The existing works at Fort Schuyler consist of an old masonry fort, planned half a century ago, and of three incomplete and unarmed earthen batteries.

During the past fiscal year the sea-wall has been repaired, and also the slope in front of the glacis battery.

The preparation of all but the iron-work of one turret to receive two 110-ton guns should be no longer delayed.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

Fort at Willets Point, eastern entrance to New York Harbor, in charge of Lieut. Col. H. L. Abbot, Corps of Engineers, until March 11, 1886; *since that date in charge of Lieut. Col. C. B. Comstock, Corps of Engineers.*—This work, together with Fort Schuyler, forms the only defensive line for preventing an enemy coming from the direction of Long Island Sound from entering the harbor of New York City. It is, therefore, of first importance.

The defensive works at Willets Point consist of an old stone fort, begun at the outbreak of the civil war and left unfinished since 1865; of four unfinished earthen batteries for guns, and of a battery for sixteen mortars.

During the past fiscal year the roads and temporary buildings have been repaired, and property has been cared for.

The extensive slopes have had the grass cut upon them.

The sea has been cutting away the shore line on the east front, south of the main work, and blocks of granite, long on hand, have been placed here to form a bank protection. This protection needs extension further to the south.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

Defenses of Governor's Island, New York Harbor, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February* 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—These works comprise Fort Columbus, Castle Williams, South Battery, and New Barbette Battery. They, with Fort Wood, on the opposite side of the channel, defend the entrances to the East River and the Hudson River. The fortifications on Governor's Island were commenced in 1831. The exterior heavy earthen batteries are as yet unfinished.

For years past no special appropriation has been made for any of the works on this island, and the operations during the year have been limited to repairs.

The United States owns the whole island, an area of 70 acres.

During the year eight interior magazine doors were built and hung in the magazines of the New Barbette Battery, and 8 entrance stones to cover drains were laid in the entrances of the magazines. Slight repairs were made to the bridge over the ditch at Fort Columbus.

An exterior modern earthen battery, designed by the Board of Engineers for Fortifications, and approved by the Secretary of War, is partially built. The plan of this battery requires revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Sea-wall on Governor's Island, New York Harbor, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February* 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—The project for this improvement, adopted in 1865, provides for inclosing the entire island by a sea-wall.

Under an allotment made in 1865, 700 linear feet of masonry wall were built on the southwest side of the island in 1866, which, with about 399 linear feet built under other small allotments, made a total of 1,099 feet. This was subsequently extended as a temporary dry wall nearly along high-water mark to Castle Williams, covering the entire southwest side of the island. By act approved August 7, 1882, $39,000 were appropriated "for completing a sea-wall already commenced on the southwest side of Governor's Island, New York Harbor, and constructing a sea-wall on its southeastern portion." Under this appropriation and one of $15,000, included in the sundry civil bill approved March 3, 1883, the wall was extended 206 feet along the south side of the island, and 1,502½ feet along the east side to the coal wharves. From this point the island is inclosed by wharf fronts and by the "ordnance wall," extending around the northeast side and along the northwest side to within about 1,100 feet from the Engineer Wharf and the Castle Williams Wall. In 1884 an allotment of $500 was made for completing the filling and grading behind the east wall, left unfinished on account of exhaustion of funds.

In order to complete the project for inclosing the entire island, there is yet to be built about 1,100 feet of wall on the northwest side, and the temporary dry wall is to be replaced by a masonry wall about 1,500 feet

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

long, the latter to be built near low-water line, using the material in the present dry wall as far as it will go; also filling in and grading behind the walls when built.

No work was done during the past fiscal year, no funds being available.

From the western extremity of the "ordnance wall" to Castle Williams, a distance of 1,100 feet, the beach is wholly unprotected against deposits of offal, dead animals, and other objectionable matter. For carrying the sea-wall in front of this beach and for banking up the low spaces behind it, an estimate of $50,000 is submitted; to replace the dry wall with a permanent masonry wall will cost about $50,000 additional. Both walls could be built to advantage in a single year.

An appropriation of $50,000 is recommended.

Fort Wood, Bedloe's Island, New York Harbor, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February* 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—This work, commenced in 1841, forms one of the inner line of defenses for New York Harbor, and with those on Governor's Island is designed to close the entrances to the East River and the Hudson River, and to protect New York, part of Brooklyn, and Jersey City from bombardment.

The entire island belongs to the United States; its area is about 13 acres.

The exterior modern earthen battery, designed by the Board of Engineers and approved by the Secretary of War, is only partially built and should be completed. The plan requires revision.

The pedestal for the Statue of Liberty Enlightening the World is completed; the interior frame-work is erected up to the neck and the iron skeleton of the right arm is partly in place; preparations are being made for placing the copper plates of the statue.

The only work done upon the fortifications during the past fiscal year was fitting and hanging three interior magazine doors in the new exterior battery.

The slopes and platforms are in good condition.

No appropriation having been made, no work was done at this fortification during the past fiscal year, beyond what was necessary for its repair and preservation; for the same reason no work is contemplated during the ensuing year.

No appropriation asked for next fiscal year.

Fort Hamilton and additional batteries, New York Harbor, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *since that date in charge of Lieut. Col. Walter McFarland, Corps of Engineers.*—These works, commenced in 1824, are situated at the Narrows of New York Harbor, upon the Long Island side.

No specific appropriation was made for the fiscal year, and the operations were confined to repairs absolutely necessary for the preservation of the works.

These include, in Battery No. I, the placing of 1,190 cubic yards of riprap stone against the sea-wall supporting the battery, making and hanging four interior and seven exterior magazine doors, and setting pintles in platforms 1, 2, 5, and 6; in 15-inch Gun Battery, making and hanging one interior door to Magazine B.

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

The slopes, revetments, and platforms of all the several works are in good repair and the magazines are dry and serviceable.

To construct a working-chamber on the east side of the channel for the torpedo defensive system planned by the Board of Engineers, an appropriation is requested under the general appropriation for cable galleries, &c.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Mortar Battery at Fort Hamilton, New York Harbor, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *since that date in charge of Lieut. Col. Walter McFarland, Corps of Engineers.*—This battery was commenced in 1871. No operations were carried on during the year except furnishing and hanging three exterior magazine doors.

But little requires to be done to fit this battery to receive its full armament as projected by the Board of Engineers for Fortifications.

Fort Lafayette, New York Harbor, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *in charge of Lieut. Col. Walter McFarland, Corps of Engineers, until February* 17, 1886; *since that date in charge of Lieut. Col. D. C. Houston, Corps of Engineers.*—This old work, commenced in 1812, occupies the best of all the positions for the defense of New York Harbor; it is situated on a shoal at the Narrows entrance, and is wholly surrounded by water of 8 feet depth or more. The area inclosed by the sea-wall is about 270 feet square. The fort was injured by fire in 1868 to such a degree as to make it practically worthless unless repaired at a very considerable expense. As it was adapted to guns of small caliber only, it was not thought advisable to restore it, but to replace it with an iron construction which should meet the demands of modern armament. Plans for this have been proposed.

The defense of New York requires a new work which will mount the heaviest modern ordnance, and, as many years will be consumed in the construction, an adequate appropriation should be made without further delay.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Wadsworth, Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This fort, commenced in 1847, is situated on the west side of the Narrows, and constitutes a part of the second line of defense of the southern water approach to New York.

It is an inclosed work, built of granite, containing three tiers of guns in casemates and one *en barbette*, the lower tier being only a few feet above the water-level.

The work, in connection with those adjacent to it on either side—Fort Tompkins and the two glacis batteries on the hill in rear—is designed to throw a heavy concentrated fire on vessels approaching or attempting to pass through the Narrows, crossing its fire with that from Fort Hamilton and batteries on the opposite side of the channel.

During the past fiscal year the permanent gun platforms and the breast-height walls were pointed. A rough, low retaining wall was

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

built about half-way down the long slope, to prevent the earth from washing down from above.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort on site of Fort Tompkins, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work, commenced in 1858, with the earthen Glacis Gun Battery on its left and the Glacis Mortar Battery on its right, crowns the hill in rear of Fort Wadsworth and the earthen batteries known as North Cliff Battery, South Cliff Battery, Battery Hudson, and the South Mortar Battery.

It is an inclosed pentagonal work, having on its four land faces two tiers of casemate quarters, a deep, dry ditch, and a heavy barbette battery to resist a land attack, and on its channel front seventeen large casemates for storage and other purposes. It mounts its channel-bearing guns *en barbette*. It is intended to supply quarters for the garrison, and act as a keep for all the defensive works occupying this position. Properly armed, this work will be able to throw a heavy fire from a commanding position upon vessels attempting to pass through the Narrows.

The four land faces were, for all defensive purposes, finished in 1865. In December, 1869, a plan giving such increased depths to the casemates that heavy rifled guns could be mounted over them *en barbette* was adopted and carried into execution.

Since 1876 the work has been in readiness to receive, on temporary platforms, all the heavy guns intended for channel defense.

The following work was done during the past fiscal year:

The pointing of the masonry of the scarp and counter-scarp walls was continued. The torpedoes stored at the fort, and the balcony of the parade walls, and other exposed iron and wood work were painted. Extensive damages caused to the exterior slope of the channel-front by a heavy rain-storm in April, 1886, were thoroughly repaired. The work of macadamizing the road leading from the south sallyport of the fort to the light-house was commenced.

The western boundary fence at the foot of the glacis, along New York avenue, was renewed and painted.

Grass and weeds were cut on the parade, parapet, and slopes of the fort.

The estimates for the completion of Fort Tompkins comprise ten permanent gun platforms in place of the present wooden ones, four bonnets on the traverses for the better protection of guns and gunners, and finishing off twenty-six casemates for quarters and eleven large casemates on the channel-front for storage purposes.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is comtemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Glacis Gun Battery (north of fort on site of Fort Tompkins), Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of En-

gineers.—This earthen barbette battery, built in 1872, is designed to supplement the barbette fire of Fort Tompkins. It has been in readiness to receive its armament on temporary platforms for the last twelve years, and may be reported as finished. It is provided with timber gun platforms and ample magazine room.

But little work was done at this battery during the past fiscal year. The slopes, which had been damaged by a heavy rain-storm in April, 1886, were repaired, the doors of the two magazines were painted, and grass and weeds cut on the slopes and in rear of the work.

The cost of substituting stone for the timber gun platforms and raising the breast-height wall will be $15,000.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Glacis Mortar Battery (south of fort on site of Fort Tompkins), Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This battery, built in 1872 and 1873, is intended to throw a powerful vertical fire upon vessels approaching or attempting to pass through the Narrows. It is provided with ample storage and service magazine room, but the ten wooden platforms for 13-inch sea-coast mortars have become unserviceable from decay.

During the past fiscal year the doors of the service magazines were painted, and the slopes, which had been damaged by a heavy rain-storm in April, 1886, were repaired. Grass and weeds were cut from the slopes of parapets and magazine covers.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Battery Hudson, Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work, built in 1841 to 1843, and the North Cliff and South Cliff batteries occupy the slope of the hill between the fort on site of Fort Tompkins and the water, and are able to bring a powerful direct fire upon the channel leading up to and through the Narrows.

For want of funds no work except that of preservation and repair has been done since the close of the fiscal year ending June 30, 1876. One of the new platforms was constructed for King's depressing carriage and a 15-inch smooth-bore gun mounted thereon.

The work necessary for the completion of this battery comprises twelve new permanent gun platforms in place of old ones, the construction of a new breast-height wall in front of some of the platforms, and raising the wall to a higher level in front of others, the construction of bonnets on the traverses, and the placing of a wooden lining in one of the principal magazines, at an aggregate cost of $45,000.

The following work was done during the past fiscal year:

Two wooden front-pintle platforms for 8-inch converted rifles were constructed in the western wing of the south front, upon the concrete foundations previously occupied by two decayed wooden platforms for

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

15-inch smooth-bore guns. Two 8-inch converted rifles, formerly in the first tier of casemates of Fort Wadsworth, were mounted upon the new platforms.

The lower part of the long earth slope in rear of the permanent front-pintle platform on the south front, next to the angle with the east front, was cut off to the height of about 5 feet, and replaced by a wooden revetment. This was done to give room for the long chassis of an 11-inch rifle received and mounted here during the year.

Miscellaneous repairs were made to slopes, and grass and weeds cut on them. A new shingle roof was put on the hostler's building, and repairs were made to the cement-shed and blacksmith's building; both received new underpinning where they had settled.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

South Mortar Battery (in rear of Battery Hudson Extension), Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This battery, commenced in 1872, is situated south of Fort Tompkins and directly in rear of Battery Hudson Extension. It is designed to throw a heavy vertical fire upon vessels approaching the Narrows from the lower bay. Since 1873 no appropriation has been made for it. The work necessary for its completion consists in constructing and laying eight timber mortar platforms, and in fitting up the inner magazines with doors and lamp-closets. Estimated cost of completing the work, $10,000.

The work done at this battery during the past fiscal year was confined to cutting grass and weeds on the slopes.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

North Cliff Battery, Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This earthen gun battery, which was commenced in 1862, is located north of Fort Wadsworth, on the slope of the hill between Fort Tompkins and the water. It is designed to throw a direct fire upon vessels attempting to pass through the Narrows. It was intended for an armament of 15-inch smooth-bore guns or corresponding rifles, and was provided with two storage magazines, one large bomb-proof shelter, and five traverses between guns, two of them containing service magazines. Under a modification approved December 8, 1859, the bomb-proof shelter was suppressed and some traverses and service magazines between the guns were added, the number of guns being necessarily reduced thereby.

During the last fiscal year operations were confined to repair of damages to the slopes in rear of the work, caused by a heavy rain-storm in April, 1886, and in cutting grass and weeds from these slopes and from the parapet and magazine covers.

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

The cost of finishing this battery, by substituting six stone gun platforms for those of timber, constructing six breast-height walls, two bonnets on the traverses, lining the two principal magazines with wood, thickening the parapet, and constructing a rough sea-wall at the foot of the exterior slope, will be $60,000.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

South Cliff Battery, Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This earthen gun battery, occupying the slope of the hill between Fort Tompkins and the water directly south of Fort Wadsworth, was built in 1858 to 1861, for 15-inch guns or corresponding rifles, and was provided with two storage and two service magazines. In December, 1869, modifications were ordered, adding four new traverses, including two traverse magazines, by which the number of guns was necessarily reduced.

No work was done at this battery during the past fiscal year beyond cutting the grass and weeds from the slopes.

The cost of finishing the battery, comprising the completion of four traverses, the construction of one new traverse magazine, adding to the thickness of a parapet, building a rough sea-wall at the foot of the exterior slope, and lining the two principal magazines, will be $60,000.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Two-gun Battery (near southeast angle of channel front of fort on site of Fort Tompkins), Staten Island, New York Harbor, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work is located on the crest of the long slope in rear of Fort Wadsworth, and to the southeast and somewhat in advance of the channel front of the fort on site of Fort Tompkins. It was built towards the close of the late civil war, and is designed to throw additional fire from a commanding position upon vessels attempting to pass the Narrows.

The only work done here during the past fiscal year consisted in cutting grass and weeds on the parapet and adjoining slopes.

The battery contains two permanent center-pintle platforms for 10-inch or 8-inch Rodman guns or corresponding rifles. Platforms, breast-height, and parapet are in serviceable order, but there is no service magazine.

No appropriation is asked for this work.

Fort at Sandy Hook, New Jersey, in charge of Maj. George L. Gillespie, Corps of Engineers, until February 3, 1886; *since that date in charge of Lieut. Col. Walter McFarland, Corps of Engineers.*—This casemated work, commenced in 1857, commands the southern approaches by sea to the harbor and city of New York, and is also designed to prevent the occupation of the Lower New York Bay, as an anchorage by an enemy's fleet.

DEFENSES OF NEW YORK AND THE NAVY-YARD AT BROOKLYN—continued.

No regular appropriations have been made for years past for the completion or modification of this work, and it remains in essentially the same condition as at the date of the last annual report.

No work has been done upon the jetties for protecting the site against the advances of the ocean, and they have suffered no serious damage.

This water-front is now in a good condition, affording protection to all buildings in rear.

The defensive work upon the Hook is the most advanced of all the defenses of the southern approaches by sea to the harbor and city of New York. The channel of entrance opposite the Hook is more than a mile wide, and of depth sufficient for the largest and most powerful armored vessels yet built or designed. The occupation by an enemy's fleet of the capacious bay just within the Hook would prevent all egress from the harbor southward to the sea, and effectually seal up the main outlet from the city. The modification and completion of this important work for the reception of the heaviest modern rifled guns protected by impenetrable iron armor, and the protection of the site against encroachments by the sea, are of very great importance.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

DEFENSES OF PHILADELPHIA AND LEAGUE ISLAND NAVY-YARD.

Fort Mifflin, Delaware River, Pennsylvania, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—This barbette work, originally established in 1779, is situated on the west bank of the Delaware River, within the territorial boundaries of the city of Philadelphia, and constitutes a part of the inner line of works for the defense of the city and the League Island naval station.

No specific appropriation has been made for this fort since 1875, when the operations which were in progress in the construction of exterior earthworks for the mounting of heavy guns, under the approved plans of the Board of Engineers for Fortifications, terminated. These plans require revision.

During the past fiscal year the public buildings were cleaned and whitewashed, the grass on the grounds of the main work and demilune cut, and a wagon bridge built across the ditch in front of the main entrance to the fort.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Mortar Battery at Fort Mifflin, Pennsylvania, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—The site of this battery is on the reclaimed land west of the main work and north of the unfinished gun battery. Operations for its construction began in 1871, and continued until near the close of the fiscal year 1874, since which time work has remained suspended for want of funds.

DEFENSES OF PHILADELPHIA AND LEAGUE ISLAND NAVY-YARD—continued.

This battery, the plans of which were prepared by the Board of Engineers for Fortifications, remains in an unfinished condition, and is suffering from exposure.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Site for defenses at Red Bank, New Jersey, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—This site is situated on the east shore of the Delaware River, and embraces an area of 100 acres. It was purchased in 1872, with the view of erecting thereon an earthen barbette work for heavy guns, which, with the works at Fort Mifflin, would constitute the inner line of defenses of the Delaware River.

During the past fiscal year operations were confined to placing 114 cubic yards of rip-rap stone at the foot of the bluff directly in front of the property-keeper's house, where the bank was being rapidly washed away by the river currents.

No appropriation has been made for this work. The site is an important one, the occupation of the bluff by a suitable armament, which would command the channel at short range, being indispensable to any attempt to defend the port of Philadelphia and the League Island navy-yard.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Fort Delaware, Delaware River, Delaware, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—Fort Delaware is a casemated work, with granite scarp, situated on Pea Patch Island, about 42 miles below Philadelphia, and 12 miles below Wilmington, Del.

The position is a very important one, commanding both channels, the eastern or main ship-channel passing within 1,000 yards of the fort.

The masonry of this fort was begun in 1852. No appropriations have been made for it since 1876, and the modifications then in progress, to adapt it to the greater size and power of modern ordnance, remain suspended.

This work and the batteries opposite on the Delaware and New Jersey shores form the lower line of defense for the Delaware River, but the fort is in no condition to contest the passage of modern ships of war, and the thickness of neither the scarp nor the magazine walls is sufficient to resist shot from guns now in use.

During the past fiscal year available funds have been applied to the following work:

Two barbette gun platforms, Nos. 103 and 104, were so modified as to adapt them to the modern iron carriages. This work, with the platforms similarly modified in previous years, completes the modifications of all the center-pintle stone platforms for the barbette Rodman guns. Seven stone platforms, which were from ½ to 1⅜ inches out of level, were releveled by cutting down the stone-work and relaying the traverse circles. The grounds have been partially cleaned from weeds and minor repairs made to ditches.

DEFENSES OF PHILADELPHIA AND LEAGUE ISLAND NAVY-YARD—continued.

An appropriation for constructing a torpedo casemate is asked for, under the general appropriation for cable galleries.

No appropriation having been made no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

Battery at Finn's Point, Delaware River, New Jersey, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—The construction of this earthen barbette battery, which forms the left of the lower line of defense for the Delaware River, was commenced in 1872, under the approved plans of the Board of Engineers for Fortifications. In 1876 work was suspended for want of appropriations, and since then only slight repairs have been made from time to time.

During the past fiscal year slight repairs were made to the dikes and sluices. The sea-wall along the front of the work has been but partially completed, leaving a gap of about 650 feet. Along the length of this gap the shore-line and a part of the exterior slope of the battery have been seriously eroded by the action of the river, and stone has been disposed along the foot of the eroded bank, so as to give temporary protection until available funds would permit of the stone being laid into a wall closing the gap.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Mortar Battery at Finn's Point, Delaware River, New Jersey, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—This work was commenced in 1872, under the approved plans of the Board of Engineers for Fortifications, and forms a part of the earthen battery at Finn's Point. No appropriations having been made for it since 1874, it remains in its then incomplete condition. Since then the embankments have been washed away to a great extent by severe storms, which badly damaged the sea-wall at their foot.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort opposite Fort Delaware, Delaware shore, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—This earthen barbette battery is on the Delaware shore, opposite Fort Delaware, and commands both channels of the river below Pea Patch Island.

Its construction was commenced in 1873, and continued until 1876. Since that time no appropriations have been made, and the battery remains in an unfinished condition. The completed portions, including the sodded slopes, are in fair condition. The dike on the Delaware River front needs extensive repairs. The plan of the battery requires revision. An appropriation for completing the torpedo cable gallery is requested under the general appropriation for cable galleries.

DEFENSES OF PHILADELPHIA AND LEAGUE ISLAND NAVY-YARD—continued.

During the past fiscal year slight repairs were made to the buildings, fences, and two service magazines.

No appropriation having been made, no work was done at this fortification during the last fiscal year, and no work is contemplated during the current fiscal year for the same reason.

Mortar Battery, opposite Fort Delaware, near Delaware City, Delaware, in charge of Lieut. Col. Henry M. Robert, Corps of Engineers.—This work was commenced in 1872, under the approved plans of the Board of Engineers for Fortifications. No appropriation having been made for it since 1874, it remains in its then incomplete condition. Since then the embankments have been washed away to a great extent by severe storms, which badly damaged the sea-wall at their foot.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF BALTIMORE.

Fort McHenry, Baltimore Harbor, Maryland, in charge of Lieut. Col. William P. Craighill, Corps of Engineers.—This fort forms part of the inner line of defense for Baltimore and its dependent interests, and commands with its fire the interior waters of the harbor and the channel of approach thereto, in which latter a depth of 27 feet exists at mean low water.

The fortifications at this place were commenced in 1775, and in 1794 the present work was built.

Although the original fort has become almost useless as a defensive work, the site is still an important one, and the water-front should be occupied by a battery of modern guns, mounted behind an earthen parapet of the most approved dimensions, and provided with bomb-proof cover for ammunition and gunners. Such a battery, the plans of which were prepared by the Board of Engineers for Fortifications, was commenced in 1872, and is partly constructed, although all work upon it has been suspended for want of funds since July, 1876. The plan of this battery requires revision.

A bulkhead of ballast having been made by the United States, without expense, along a line in front of the site, and at a distance from the authorized pier line of 375 feet, and a line having also been established in the rear of the site at the same distance from the pier line, it is proposed to fill in the whole area thus defined with ballast from ships coming to the port. The available limits of the site will thus be largely increased without expense to the United States. Little progress has been made in this filling during the past year, as but few vessels have applied to deposit ballast upon the area.

A sea-wall should be built along the line of the temporary bulkheads referred to above, and the present wharf should be removed and a new one built near the new dry-dock.

The repairs for the year have consisted of the following items: Mowing slopes of main work and the exterior batteries; cleaning out and readjusting some of the drains; replacing broken slates on the large

DEFENSES OF BALTIMORE—continued.

storage magazine near the hospital; setting three of the coping-stones of the sea-wall; readjusting and sodding some of the slopes of the demilune battery; filling, readjusting, and sodding two slips in the old outer battery.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Carroll, Baltimore Harbor, Maryland, in charge of Lieut. Col. William P. Craighill, Corps of Engineers.—This fortification, commenced in 1847, is situated upon an exterior line of defense for the harbor of Baltimore.

It has been proposed to modify this fort so as to enable it to be properly available for its intended purpose; the modifications to be in accordance with the requirements of warfare of the present day. Its completion is indispensable to the safety of the rich city of Baltimore in time of foreign war, and the work to be done cannot safely be left until the approach of hostilities. It will require several years and liberal appropriations to accomplish it, and it should be commenced without delay.

Operations during the past year have been confined to the general care and preservation of the work and the public property stored thereat.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

DEFENSES OF WASHINGTON.

Fort Foote, Potomac River, Maryland, in charge of Maj. Peter C. Hains, Corps of Engineers.—This earthwork is situated on the left bank of the Potomac River, and only 2 miles below Alexandria. It commands the water approaches to that city and to Washington.

The work was commenced in 1862. In 1872 the Board of Engineers for Fortifications approved a project for the modification of the old fort and for the construction of an additional battery. Work was in progress on the former when a suspension became necessary by reason of the failure of appropriations. No work has ever been done on the proposed new battery and none on the old fort since 1874.

At the present time the condition of the work may be described as one of utter dilapidation. The magazines, which at the time of the suspension of operations were in an unfinished condition, are rapidly going to ruin. The parapet on the water front was hardly begun when work ceased. There are five gun platforms laid, four front, and one center pintle. They are built of concrete and granite, and are serviceable. The plans of the work require revision.

The buildings are all built of perishable material, and rapidly going to decay. As the post is not occupied by troops, it is not deemed expedient to repair all of them. Slight repairs to two sets of officers' quarters and the hospital are recommended.

DEFENSES OF WASHINGTON—continued.

During the past year traverse rails and pintle plates were laid for two 15-inch guns, one set of officers' quarters was painted, the roads repaired, and slopes mowed.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Washington, Potomac River, Maryland, in charge of Maj. Peter C. Hains, Corps of Engineers.—The construction of this fort was begun in 1816. It is a casemated work, occupying a commanding position on the left bank of the Potomac River, 11 miles below the city of Washington, and constitutes an important part of the outer line of defense of Washington and the Washington navy-yard.

The masonry of the old work is still in good condition, but as the fort was designed more than half a century ago, it is not adapted to receive guns of modern size, or to defensive purposes against such guns.

In 1870 the Board of Engineers for Fortifications approved plans for a modification of the demilune, converting it into a battery of modern construction, with guns of large caliber. The platforms for four of these guns were built, and the magazines partially so, when work was suspended for lack of funds. Three other batteries were planned, and received the approval of the Board of Engineers for Fortifications, but no work has yet been done on them.

The plans of these batteries should be modified to conform to the latest improvements in defensive works before their construction is begun.

The fort itself will also need modification for the same reason, but the unfinished magazines in the demilune battery ought to be completed, to prevent deterioration and decay.

Traverse rails and pintle plates for four 15-inch gun platforms were laid early in the present fiscal year. The slopes have been mowed, and slight repairs made to some of the buildings. Two of the magazines were cleaned out and ventilators put in. The magazines require additional work to put them in good condition. A part of the boundary fence of the reservation, which had rotted and disappeared, has been rebuilt.

There has been no special appropriation for this work since 1873–'74. The unfinished parts of the demilune battery are therefore suffering constant deterioration.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Obstructions of the Potomac, in charge of Maj. Peter C. Hains, Corps of Engineers.—The material pertaining to these obstructions was continued in store at Fort Foote, Maryland. The timber portion has become entirely worthless from decay. The irons are in good condition.

DEFENSES OF HAMPTON ROADS AND GOSPORT NAVY-YARD.

Fort Monroe, Old Point Comfort, Virginia, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This extensive work, commenced in 1817, occupies an important position, covering, in co-operation with Fort Wool, on the opposite side of the channel, the only approach from the sea to Hampton Roads, the cities of Norfolk and Portsmouth, the Gosport navy-yard, and the James River.

These works, also, in offering a safe rendezvous for our own vessels of war, afford indirect protection to Baltimore, Annapolis, and Washington, and all the harbors and towns on the Chesapeake Bay and Potomac River. The work covers an area of 86 acres, and the distance around it is 1¾ miles.

The modifications that have been planned and approved for adapting Fort Monroe to the requirements of efficient defense against war vessels of recent type contemplate arming the channel front of the advanced redoubt with heavy barbette guns, provided with suitable traverses and traverse magazines; mounting a similar armament in the re-entering place of arms, located on the right of the redoubt in advance of Front No. 5; constructing a new open battery for barbette guns to the right of the old casemated water battery; and placing a few heavy guns in the salients of the main work and covered way. There is plenty of room for mortar batteries both within and without the work.

The work of making the requisite modifications has been suspended for several years past for want of appropriations.

It is expected that the changes finally adopted will be of a much more radical character than those to which reference has been made.

In the advanced earthen redoubt the two traverse magazines are finished, except the earth covering to one of them, and six gun platforms are nearly completed. Most of the earthwork of the redoubt is also finished. In the place of arms the concrete masonry of the service magazine is finished, but not covered with earth, and the concrete foundations for the gun platforms have been laid. The new ten-gun earthen battery has not been commenced.

The following operations have been carried on during the past fiscal year:

Traverse irons were laid on two platforms for 15-inch guns at the battery east of the casemated water battery, and the parapet and exterior slope were repaired and sodded.

Platform No. 96, for 8-inch or 10-inch Rodman guns, on left flank of bastion 3–4, main work, was put in serviceable order.

Repairs were made to a section of the parade wall near the flagstaff bastion, Front I. A new road-bed was laid on the winding ramp of bastion 3–4, formed of rubble, gravel, and some clay. Repairs were made to the parapet of Front IV, where 600 square feet of new sods were laid. The interior slope of bastion 5–6 was thoroughly repaired; 115 linear feet of revetment, 3 feet high, extending along the foot of the slope, was entirely rebuilt, and 156 linear feet of blue-stone coping reset. A long crevice, 2½ inches wide, in the scarp wall of Front V, was filled with concrete and pointed. Some repairs were made to the concrete road-bed in rear of the covered way, water battery, and the brick walk through the southern postern taken up and relaid.

Repairs were made to magazine No. 2, Front II; new floor timbers and planks were laid, walls and ceilings put in order, and two oak-wood gratings fitted to cover dust-holes.

The seven iron leaders that take water from the top of the large magazine near Carroll Hall have been cleaned out and lacquered; at the mouth of each pipe an excavation was made and a drain formed, loosely filled with broken brick and stone.

The bridge leading across the ditch to the main sallyport, Front VII, was thoroughly repaired and painted, and the brick piers pointed. The gates and iron gearing of sallyports were painted.

The sluice-gates next to Mill Creek, Fronts VI–VIII, were altered by shifting them to the Mill Creek side of the frame-work. By this arrangement the water in the ditch is admitted through the sluice-way in advance of Front V, and passes out through the sluice of Fronts VI–VII. Heavy iron latches are fitted to the gate, to be used whenever it is considered necessary to hold the water-level in the ditch at the proper height to obtain the requisite head for flushing the main sewer. Galvanized iron wire screens were fitted in the sluice-ways to prevent floating objects from entering the ditch.

Miscellaneous repairs were made to the Engineer office, Engineer quarters, stable, and fences; cisterns were cleaned out and pumps put in working order where necessary. Privies at all the buildings under the control of the Engineer Department were altered and fitted with galvanized-iron receptacles, to replace the wooden boxes heretofore used.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Artesian well at Fort Monroe, Virginia, in charge of Col. Q. A. Gillmore, Corps of Engineers.—No work was done during the last fiscal year, and none is contemplated during the present fiscal year, for want of funds. The present depth of the well is about 900 feet, and in view of the importance of an independent supply of water in case of the interruption of other sources, it is recommended that this be increased to 1,200 or 1,500 feet before abandoning the project.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Fort Wool, Hampton Roads, Virginia, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work unites with Fort Monroe in closing the sea approach to Hampton Roads, being located on the opposite side of the channel from that work, and therefore crossing its fire with it.

Fort Wool is an inclosed casemated fort. It was begun in 1818 by forming an artificial foundation with stone of random sizes, unloaded upon a 10 foot shoal, selected as the site of the work. When the scarp-wall and piers had reached a height to include the lintels of the lower tier of embrasures settlement began, and work was stopped after piling a quantity of stone upon the walls sufficient to bring upon the foundation a pressure somewhat exceeding that of the finished work.

The work of construction was resumed in 1858, and when it was suspended fifty-two casemates of the lower tier, with iron-throated embrasures, were finished and ready for the guns. On the second tier the scarp-wall and piers of those portions of the work bearing on the channel had reached nearly to the height of the embrasure lintels, the embrasure irons had been set, and the floors of most of the casemates paved. On the gorge faces very little work had been done.

The work done during the past fiscal year consisted in making slight repairs to the fort-keeper's quarters; cleaning the cistern and repairing its side walls; constructing a landing for small boats from material taken from the old wharf, which is now a useless wreck; and repairing and painting the Engineer yawl-boat.

It is designed to modify this important work so that it may receive the heaviest modern rifled guns, protected by impenetrable iron armor. The work to be done, which will require several years for its execution, cannot be left until the near approach of war.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

DEFENSES OF BEAUFORT HARBOR, NORTH CAROLINA.

Fort Macon, Beaufort Harbor, North Carolina, in charge of Capt. W. H. Bixby, Corps of Engineers.—This fort forms the sole military defense of Beaufort Harbor and its attendant interests. It commands with its fire all the inner waters of the harbor and the channels of approach thereto.

Although the old fort in itself has become almost useless as a defensive work, the site is still an important one, and its water-front should be occupied by a battery of modern heavy guns, mounted upon a sand parapet of the most approved model and provided with bomb-proof cover to ammunition and gunners.

The masonry of the fort is in places badly cracked, apparently due to unequal settlement of the foundations; but these cracks have not materially changed for several years past; and the foundations, which have apparently entirely stopped settling, are probably in good condition. All the wood-work and iron-work of the fort is rotting and rusting everywhere, and the plastering is falling from the walls and ceilings of the casemates. There are three small powder magazines inside the fort, all of which are in good order. The wooden buildings on the post, used for quarters and for storage, are of a temporary character, and they are in about as serviceable a condition as is necessary for their present uses.

There being no special appropriation for the fiscal year ending June 30, 1886, operations have been confined to the general care and preservation of the work. These operations have consisted mainly in extending backward the main jetty, in repairing the fence encircling the fort slopes, and in keeping the fort and slopes in general good order.

The site of the fort has needed further protection against the ocean. As no funds were available for this, and as Fort Macon Point forms, also, one side of the entrance to Beaufort Harbor, its site has to a certain extent during the last year been protected at the expense of the Beaufort Harbor appropriations. The most important work of this nature is the partial rear extension of the main jetty, the partial construction of a jetty opposite the old railroad wharf, and the construction of a small landing wharf.

Further protection against the neighboring river and ocean is needed. The other jetties (constructed in 1844-'45 and 1883-'85) have all given excellent results; but the railroad jetty should be completed at a further expense of $3,000.

DEFENSES OF BEAUFORT HARBOR, NORTH CAROLINA—continued.

A project for adapting this work to the requirements of modern defense is under consideration.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF WILMINGTON.

Fort Caswell, mouth of Cape Fear River, North Carolina, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This barbette work, commenced in 1826, covers the entrance into Cape Fear River, and hence the water approach to the city of Wilmington, and constitutes the only defense of that locality.

Upon its evacuation by the Confederate forces in January, 1865, an attempt was made to blow it up. All the scarp-wall of the southeast face was overturned by a mine exploded in the scarp gallery of that face; a portion of the scarp-wall of the north and west fronts was so badly shattered by the explosion of a magazine on the covered way near northwest salient that it will have to be rebuilt, and the citadel on the parade of the work was burned. There is now neither armament nor quarters for a garrison at the place.

The subject of its modification is now under consideration.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF CHARLESTON.

Fort Moultrie, Charleston Harbor, South Carolina, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work is located on Sullivan's Island, and co-operates with Fort Sumter in defending the water approach from the sea to the city and harbor of Charleston. It is an earthen barbette work, and was commenced in 1841.

The completion of the work comprises the construction of eleven permanent gun platforms and breast-height walls, bonnets on the traverses, a portion of the masonry and all the earth covering of the bomb-proof shelter, the postern gallery, a part of the earth covering of the magazines, and an earthen cover-face on the channel front.

During the past fiscal year the part of the parade fence which had been destroyed by a storm on August 25, 1885, was rebuilt; the slopes were mowed, and some general clearing up of the inside of the fort done. The flag-staff, which had been blown down, was reset.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Sumter, Charleston Harbor, South Carolina, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This casemated work is located on a shoal on the south side of the entrance into the harbor, and its guns, crossing their fire with those of Fort Moultrie, on Sullivan's Island, command the only channel of approach thereto practicable for vessels of war.

Its construction was begun in 1829, and was nearly finished, although still wanting most of its armament, when, in April, 1861, it was captured by the Confederate forces.

The reconstruction of the work, with the view of adapting it to the con-

DEFENSES OF CHARLESTON—continued.

ditions of modern defense, was begun in 1870, and is now well advanced. Of the barbette gun platforms required eight have been laid. Three of these eight are permanent and five are of timber. Eight casemates on the northwest face are ready for the guns, except the traverse rails, and the nine casemates on the northeast face, one in the *pan coupé* between the northeast and north faces, and one adjacent thereto on the north face (eleven in all) are armed.

The completion of this work comprises the construction of seven permanent gun platforms and their breast-height walls, placing bonnets on the traverses, most of the earthwork on the gorge face and the parados and magazines adjacent thereto, the arrangement of a room for torpedo defense, and the repair and extension of the wharf and other matters of detail.

The work done during the past fiscal year consisted principally in repairing damages caused by the storm of August 25, 1885. That storm washed away a great part of the exterior slope and coping of the southeast face, broke up the deck-planks of the wharf, tore away the sally-port gate, and set afloat everything movable in the fort, the water standing 5 feet deep in the center of the parade.

The wharf planks were spiked down again, and other necessary repairs made to the wharf. A large amount of sand, deposited in the casemates by the storm, was removed, and the parade cleared of *dèbris*. The ordnance sergeant's quarters, which had also suffered from the storm, were repaired, and a davit for his row-boat supplied on the wharf. The sally-port gate was rehung.

The earthwork of the southeast face was repaired. It is now sodded on the exterior slope for the whole length of this face, and the top is finished off parallel to its proposed superior slope, but 3 feet below it, the funds allotted not being sufficient to carry it to the full height.

The rotten wooden revetment in front of gun platforms Nos. 9 and 10, on the same face, was replaced by a substantial marsh sod wall, with sufficient batter to make it secure. The sea breaks against the scarp-wall of this front so heavily at times that the slopes are likely to require further repairs.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the present fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Johnson, Charleston Harbor, South Carolina, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This old work, situated on James Island, a little more than 1¼ miles west of Fort Sumter, should constitute one of the inner works in the system of defense for this locality.

It is a fort only in name, having neither armament nor magazines, but only some irregular mounds of earth, representing what remains of the battery found there at the close of the civil war.

The project for reconstructing this old work contemplates making it a battery for heavy guns and sea-coast mortars. Timber platforms for the mortars have been procured.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF CHARLESTON—continued.

Castle Pinckney, Charleston Harbor, South Carolina, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work, situated on Shute's Folly Island, about 1 mile east of the city of Charleston, is one of the interior works in the system of defense of the harbor. The work was commenced in 1829. In its present condition it is useless for defensive purposes, and is now in charge of the Light-House Board for light-house purposes.

An expenditure of about $20,000 will be required to adapt this work to the reception of an armament.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF SAVANNAH.

Fort Oglethorpe, Savannah River, Georgia, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This work, commenced in 1842, is situated about 4 miles from the city of Savannah, and forms the inner line of defense for that city.

Modifications of this work, approved January 11, 1870, so as to fit it for the reception of heavy guns, were commenced in the fiscal year ending June 30, 1873, but they were suspended some years since for want of appropriations. The plans of the work require revision.

During the past year repairs were made to the fort-keeper's house, the casemates were cleaned out, and the slopes mowed.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Pulaski, mouth of Savannah River, Georgia, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This casemated work, commenced in 1829, is located on Cockspur Island, covers the ship-channel leading from Tybee Roads into the Savannah River, and constitutes the principal defense of the city of Savannah against naval attack.

From 1872 to 1875 the work of remodeling the demilune was carried on at intervals and nearly completed. Its gun platforms were built of timber, and two 15-inch guns were mounted on the north face.

The chief work during the past fiscal year consisted in repairing a number of permanent barbette platforms for 8-inch or 10-inch Rodman guns on the four channel-fronts of the main work, viz: Three front pintle platforms on the north front; two front pintle and three center pintle platforms on the northeast front; three front pintle and three center pintle platforms on the southeast front, and six front pintle platforms on the south front; total, twenty platforms.

Lamp-closet fixtures were put in the magazines of the demilune. On October 11, 1885, during a heavy storm, the tide rose over the magazine floors to a height of 14 inches. The bridges across the moat were lifted out of position, but have since been replaced. The mud, shells, &c., clogging the flood-gate at the entrance to the moat were removed. The slopes and the parade were kept clear of grass and weeds.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF SAVANNAH—continued.

New fort on Tybee Island, mouth of Savannah River, Georgia, in charge of Col. Q. A. Gillmore, Corps of Engineers.—Plans have been prepared for defensive earthen works to be constructed on the north point of Tybee Island, for the double purpose of preventing the occupation of Tybee Roads by hostile vessels and defending the channel of approach to the Savannah River. The land necessary for the work was acquired by the United States in 1875.

The northeast shore of this reservation is protected from the inroads of the sea by three spur-jetties composed of log mattresses overlaid with brush and loaded with stone. One of these spurs, No. 2, has its shore end near the old Spanish tower; No. 1 is 1,000 feet northwest and No. 3 about 1,400 feet southeast of No. 2. These works were built in 1882.

During the past fiscal year spur-jetty No. 2 was extended about 290 feet, the work involving the use of 798.86 square yards of log mattress and 455.65 cubic yards of stone.

All the work done for protecting the sea shore of the reservation is in good condition and is accomplishing its purpose. The jetties have sanded over and the rocks where exposed are cemented together by a growth of oyster-shells and barnacles.

No appropriation for their construction has yet been made.
No appropriation asked for next fiscal year.

DEFENSES OF CUMBERLAND SOUND.

Fort Clinch, Amelia Island, Florida, in charge of Col. Q. A. Gillmore, Corps of Engineers.—This casemated work, commenced in 1850, defends the entrance into Cumberland Sound and is in an unfinished condition. A plan for modifying the work has been prepared by the Board of Engineers for Fortifications, which contemplates an armament of rifled guns and the construction of an exterior earthen battery for 12-inch rifled guns.

The following work was done during the past fiscal year: The cyclone of August, 1885, having somewhat damaged the shore protection immediately in front of the sea-wall of the fort, between spur-jetties B and C, built some years ago, the necessary repairs were made and two new spur-jetties constructed between the two just named. These new spurs are 54 and 44 feet long, respectively; they have given excellent results, the sand having filled in rapidly, at some points to a depth of over 3 feet.

A new ventilating flue was put in the barracks building inside the fort and a trap-door cut in the roof of the same building.

The weeds and grass have been cut from the fort and from the yard of the Engineer officer's quarters, and both places have been thoroughly policed and put in order during the year.

A new roof was put on the Engineer officer's quarters, a new fence built around the yard, the breakwater in front repaired, and various minor repairs made to cisterns, water-tanks, &c.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF SAINT AUGUSTINE.

Fort Marion, Saint Augustine, Florida, in charge of Capt. William T. Rossell, Corps of Engineers, until April 26, 1886; *since that date in charge of First Lieut. William M. Black, Corps of Engineers.*—This work is intended to defend the harbor and city of Saint Augustine. It was essentially completed in 1756, almost one hundred years after its commencement, and under the name of "San Marco" formed the citadel of the elaborate system designed by the Spaniards for the defense of the city. It is built of coquina, a natural shell concrete found on Saint Anastasia Island, opposite Saint Augustine. The fort has never been remodeled. A water battery was constructed along its sea-front in 1842–1843, and this is the only portion of the work which can be readily adapted for use with modern ordnance. For this purpose the platforms should be prepared for modern guns, the parapet raised and strengthened, and traverses arranged for service magazines, and bomb-proofs constructed.

Five thousand dollars were appropriated for the preservation of the fort and inclosure of its grounds in the act approved July 5, 1884. In accordance therewith a picket fence has been built along a portion of the reservation boundary line, the sea-wall and covered-way breast-height walls repaired, the bastion towers renewed, the interior walls refaced where necessary, the ramp rebuilt, and a portion of the terre-plein covered with a water-proof pavement for the protection of the casemates. In all of the repairs the original designs were followed as closely as possible.

Under an allotment from the general appropriation for the preservation and repair of fortifications, 1886, the materials for the repair of six gun platforms of the water battery were purchased.

If it is intended to fully restore the fort to its condition when left by the Spaniards, and to inclose and beautify its ground, extending the sea-wall to the north end of the reservation, an additional appropriation of $15,000 will be required.

In January, February, and March, 1886, 7,731 persons visited this fort.

Appropriation asked for next fiscal year	$10,000 00

DEFENSES OF KEY WEST.

Fort Taylor and batteries, Key West, Florida, in charge of Capt. William T. Rossell, Corps of Engineers, until November 17, 1885; *since that date in charge of Maj. W. H. Heuer, Corps of Engineers.*—These works, comprising a main casemated work of brick upon a submarine foundation, and earthen battery northeast of the main work and one to southeast of it, with two martello towers of brick on the south shore of the island, are for the defense of the important harbor of Key West.

The main work was commenced in 1844; the citadel is complete, but the cover-face on the land-faces of this is in a very incomplete condition, and only the former portion is at present of any defensive value. The barracks and quarters within the fort are in very bad order and becoming worse through decay and neglect. The walls are much in need of repointing, or some similar repairs. All the casemate platforms are generally in good condition, and the barbette platforms on the sea-faces, except those for the 15-inch guns, which, being of wood, are decayed, so as to be of no use whatever.

DEFENSES OF KEY WEST—continued.

During the past fiscal year all the scaffolding used in connection with stuccoing the walls was taken down and stored.

Five brick ventilators to magazines were built. The cistern to temporary buildings was repaired; 11,800 old brick on hand were cleaned and used for this purpose. The fences around temporary buildings were also repaired. Two quarters, two store-houses, stables, carpenter-shop, smith-shop, engine-houses, car-sheds, &c., were whitewashed and repaired.

The drains through the reservation have been thoroughly cleaned out, so that the tide now ebbs and flows through them and the ponds connected with them.

Three new bridges were built over the road crossings. The main bridge was repaired, 96 embrasures on fort, 1 locomotive and engine, 17 railroad cars, 1 hoisting engine, and 140 tons embrasure irons were scraped, cleaned of rust, and coal-tarred.

The exterior earthen batteries are suffering the inevitable deterioration due to their incomplete condition; the platforms, a combination of concrete and wood, are, because of the decay of wood, utterly useless in their present condition. The estimated cost of these batteries is $240,338, which, on account of deterioration, should be increased to $250,000.

The martello towers, in fair condition, were constructed in the early part of the war of secession, on private land, the title to which has never been acquired by the United States.

No appropriation having been made, no work has been done at these fortifications during the fiscal year beyond the guarding of the property and the protection of the works from depredation, and none is contemplated for the ensuing fiscal year, because of lack of funds, other than such work of protection, preservation, and repair as the general appropriation will permit.

Appropriation asked for the next fiscal year: For acquisition of sites of the two martello towers, by purchase or condemnation $9,000 00

DEFENSES OF THE HARBOR OF DRY TORTUGAS.

Fort Jefferson, Garden Key, Tortugas, Florida, in charge of Capt. William T. Rossell, Corps of Engineers, until November 17, 1885; *since that date in charge of Maj. W. H. Heuer, Corps of Engineers.*—This casemated work, commenced in 1846, perfectly commands the admirable harbor lying in the heart of this group of keys.

The wharf is utterly decayed, and is so far gone that it would be unsafe to roll a barrel of powder over it. To rebuild this wharf, which is absolutely necessary, will cost about $3,500.

During the past fiscal year the following work was done at this fort: Laid 16 walks around the barbette magazines; repaired and painted 10 walks around the magazines in barbette tier; painted 6 magazines; repaired 3 store-rooms in casemates; repaired magazine doors; scraped and tarred the rails in barbette tiers; tore down old machine shop and stored the lumber; repaired and painted house occupied by ordnance-sergeant; whitewashed storehouse, and painted 18 doors of powder-magazines and all windows and shutters; scraped and painted the water doors of lower casemates; cleaned and coal-tarred 290 pieces of embrasure iron.

The quarters are suffering from neglect, and the unfinished barracks should be completed. Pending the adoption of modifications which the

DEFENSES OF THE HARBOR OF DRY TORTUGAS—continued.

most modern conditions demand, no appropriation is at this time recommended. The lower tier of casemates, in which guns in casemate are alone mounted, are generally in good condition, and the barbette platforms, for the guns of the lesser calibers, are also in good condition generally, though some of them are incomplete.

The wooden platforms for 15-inch guns are thoroughly decayed and are of no use.

The scarp of the work is, in places, incomplete; the parapet is not wholly embanked, and the traverses, most of which are incomplete, are suffering from deterioration through loss of material; being formed of sand and mostly unprotected, or incompletely so, the winds blow it away.

No appropriation having been made, no work was done at this fortification during the last fiscal year except caring for the property and protecting the work and buildings from depredations, and none is contemplated for the ensuing year.
No appropriation is asked for next fiscal year.

DEFENSES OF PENSACOLA HARBOR AND NAVY-YARD.

Fort Pickens, Pensacola Harbor, Florida, in charge of Capt. R. L. Hoxie, Corps of Engineers.—This casemated work, commenced in 1828, with Fort Barrancas and the proposed new batteries near the site of Fort McRee, constitutes the defenses of the town and harbor of Pensacola and the navy-yard at Warrington. It is situated near the west end of Santa Rosa Island, and is at present the only work of defense of the entrance and main channel to Pensacola Harbor.

Plans for the modification of this work and the construction of exterior sand batteries for heavy guns were prepared by the Board of Engineers for Fortifications when Bastions C and D were modified, but since 1876 no appropriations have been made for this work, and operations have therefore been confined to the preservation and repair of the buildings and works, and to the care of the public property appertaining to the same. The plans of the work and exterior batteries require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year, and no work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Barrancas and redoubt, Pensacola Harbor, Florida, in charge of Capt. R. L. Hoxie, Corps of Engineers.—These works, commenced in 1839, are situated on the north bank of the entrance to Pensacola Harbor, opposite Fort Pickens, and are intended for defense of this entrance and protection from land attacks.

For many years operations at this work were confined to necessary repairs to masonry, slopes, and wood-work, until 1874, when the construction of four front pintle platforms for mounting new ordnance was commenced; but work was suspended before much progress was made, none of the platforms having been completed. Since that time operations have again been confined to ordinary repairs.

Plans and estimates for the construction of an exterior battery on the bluff west of the fort have been prepared by the Board of Engineers for

DEFENSES OF PENSACOLA HARBOR AND NAVY-YARD—continued.

Fortifications, but so far no appropriations have been made and no work has been done. The plans require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year, and no work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort McRee, Pensacola Harbor, Florida, in charge of Capt. R. L. Hoxie, Corps of Engineers.—This fort, situated on the west side of the main ship-channel to Pensacola Harbor, commenced in 1836, has been a ruin since the late war, and the greater portion has been washed away by the encroachment of the sea upon its site.

Plans for the construction of batteries for the heaviest modern guns and mortars near the site of the old fort, to co-operate with Fort Pickens and the works at Barrancas in the defense of this important harbor, have been prepared by the Board of Engineers for Fortifications, but as no appropriation has been made for them no work was done upon them. The plans require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year, and no work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF MOBILE.

Fort Morgan, eastern entrance to Mobile Bay, Alabama, in charge of Maj. A. N. Damrell, Corps of Engineers.—This casemated fort, commenced in 1819 and completed in 1833, is situated at Mobile Point, on the east side of the main ship-channel to Mobile Bay, and as it commands this channel from the outer bar to the lower anchorage, and forms, with Fort Gaines on the west side of the channel, the outer line of defenses to the harbor and port of Mobile, its site is of great importance, but will not be of much value as a defensive work until the contemplated water batteries for heavy ordnance along the western and southern shores are completed. As stated in former reports, the construction of these batteries was commenced in September, 1875, but work had to be suspended in April, 1876, the amount appropriated being exhausted; and as no appropriations have been made since, this work has not been resumed. The plans of the batteries require revision.

During the year fifteen iron shutters were fitted to embrasures of casemates. All ditches, drains, gutters, and casemates in the fort were thoroughly cleaned and grass and weeds cut twice. The outer gate of sallyport was repaired and a portion of joints on terreplein were repointed.

All the outbuildings, except carpenter shop, and the fences, were repaired, and slight repairs made to wharf.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Fort Gaines, Dauphin Island, Alabama, in charge of Maj. A. N. Damrell, Corps of Engineers.—This work, commenced in 1848, is, with Fort Morgan, on the opposite side of the main entrance to Mobile Harbor, designed to command that entrance and the lower fleet anchorage. It

DEFENSES OF MOBILE—continued.

needs complete modification to adapt it to the use of modern heavy guns, and plans therefor have been prepared by the Board of Engineers for Fortifications; but no appropriations having been made for this work, the fort remains in the condition as reported in former reports. The plans require revision.

During the year all the drains, ditches, and casemates were cleaned out and grass cut three times. Buildings were repaired and whitewashed.

No appropriation having been made, no work was done at the fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF MISSISSIPPI SOUND.

Fort on Ship Island, in charge of Maj. A. N. Damrell, Corps of Engineers.—This casemated fort, commenced in 1862, is located at the west end of Ship Island, on the east side of Ship Island Channel, and is designed for a fortified maritime depot of coal, provisions, &c., and for the defense of the navigation of Mississippi Sound and the approaches to New Orleans from the eastward.

During the year fourteen shot-bells were built and painted, floors of three service magazines cemented over and temporary wooden covers placed over entrances to them. All embrasure shutters put in working order and two new wooden shutters made to replace two broken iron shutters. Sallyport gate refastened, casemates, gun platforms and terreplein cleaned out; store house repaired, and forty-three panes of glass put in. Grass cut and drift sand removed twice during the year.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF NEW ORLEANS.

Fort Pike, Rigolets Pass, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This casemated work, commenced in 1819, is located on the south side of the Rigolets, a pass connecting Lake Pontchartrain with Mississippi Sound and the Gulf of Mexico. It was designed to guard the extreme eastern approach to New Orleans available for vessels drawing 7 feet or less.

During the late civil war, while in the possession of the Confederates, with the aid of obstructions in channel, it served to prevent predatory incursions of light-draught steam gunboats of the United States Navy into Lake Pontchartrain, which, no doubt, but for it, would have cut off direct communication by the lake and by rail between New Orleans and the country east of the Mississippi River.

A project for the modification of this work, to adapt it for the reception of modern ordnance, was prepared by the Board of Engineers for Fortifications in 1870, but no appropriation has been made therefor. The plans require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF NEW ORLEANS—continued.

Fort Macomb, Chef Menteur Pass, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This work, commenced in 1822, is located on the south side of the "Chef Menteur," a pass connecting Lake Pontchartrain with Lake Borgne and the Gulf of Mexico. It covers the approach to New Orleans of vessels drawing 4 feet or less *via* the pass and Lake Pontchartrain, and also the practicable approach of a land force from the pass *via* the "Gentilly Ridge" and the line of the Louisville and Nashville Railroad, which crosses the pass but a few hundred yards from the fort.

A project for the modification of this work, to adapt it for the reception of modern ordnance, was prepared by the Board of Engineers for Fortifications in 1870, but no appropriation has been made therefor. The project requires revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

Tower Dupré, Lake Borgne, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This tower, commenced in 1830, is located at the mouth of Bayou Dupré, a bayou connected with Lake Borgne, and heading near the Mississippi River about 12 miles below the city of New Orleans. It is one of the system of works designed to command the approaches to New Orleans from Mississippi Sound.

It was mainly through this bayou that the British forces approached New Orleans in 1814.

About 1873 and 1874 the bayou was converted into a canal by widening and straightening it in places and by excavation extending to within a few hundred feet of the Mississippi River. A pier was also extended into the lake. Vessels drawing 4 feet or less can now easily pass from the Gulf of Mexico *via* this canal to its end near the river.

Since the late civil war but little has been done to this work, and for the past few years nothing has been done. The tower is at present in a fair state of preservation. The parapet of the battery has nearly all been removed, and there is no armament.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Battery Bienvenue, Lake Borgne, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This battery, commenced in 1826, is situated in the sea marsh at the junction of the two main branches of Bayou Bienvenue, and about 3 miles from the mouth of the bayou. It was designed to guard against boat expeditions from Lake Borgne, *via* this bayou, to attack New Orleans in the rear of the lower portion of the city.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

Tower at Proctorsville, Lake Borgne, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This work, commenced in 1856, is one of the system of works designed to command the approaches to New Orleans from Mississippi Sound. No work was done during the past fiscal year.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

DEFENSES OF NEW ORLEANS—continued.

Fort Jackson, Mississippi River, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This work, commenced in 1822, is situated on the right (west) bank of the Mississippi River, at what is known as the Plaquemine Bend, about 70 miles below the city of New Orleans.

Together with Fort Saint Philip, situated on the opposite bank of the river, it was intended to serve in the defense of the very important port of New Orleans and its surrounding country against attack of a hostile fleet attempting their capture by way of the river.

It is an inclosed casemated work, with masonry scarps and new exterior earthen batteries, which are in an incomplete condition.

During the past fiscal year the grass has been mowed once; eight concrete and wooden platforms for 15-inch guns were replaced by concrete platforms for the same guns. The Quartermaster's Department has erected a new dwelling for the ordnance sergeant. There was also built a levee to protect the reservation from overflow. The plans of the work require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Saint Philip, Mississippi River, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—The location and purpose of this work, which was commenced in 1841, are sufficiently described in the preceding report on Fort Jackson.

It is fully as important to be maintained and properly armed as Fort Jackson. Although the latter is the larger work, the position of the former is more advantageous.

It is an inclosed barbette work, with masonry scarp and new exterior earthen batteries, which are in an incomplete condition.

During the past fiscal year work on this fortification has been confined to replacing eight concrete and wooden platforms for 15-inch guns by concrete platforms for the same guns, and to cutting the grass. The Quartermaster's Department has erected a new dwelling for the ordnance sergeant. The plans of the work require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Livingston, Barataria Bay, Louisiana, in charge of Maj. W. H. Heuer, Corps of Engineers.—This work, commenced in 1842, is located on the west end of Grande Terre Island, at the entrance to Barataria Bay, and guards the western line of approach to New Orleans offered by the bay and the bayous and canals connecting the bay with the Mississippi River opposite New Orleans. It also secures the anchorage in the bay as a harbor of refuge for coasting or other light-draught vessels in time of war.

During the past fiscal year the only work done at this fortification consisted in making a survey and preparing plans and estimates for jetties to protect the shore line of the site from further erosion by the sea.

No work is contemplated during the current fiscal year beyond its

DEFENSES OF NEW ORLEANS—continued.

protection, preservation, and repair as far as possible with the general appropriation made for this purpose.

No appropriation having been made, no work was done at this fortification during the last fiscal year except its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose.
No appropriation asked for next fiscal year.

DEFENSES OF GALVESTON.

Batteries at the entrance to the harbor of Galveston, Texas.—The object of the earthen batteries of heavy guns, recently designed by the Board of Engineers for Fortifications, to be placed on Pelican Spit, Galveston Island, and Bolivar Point, is for the defense of the entrance to the harbor of Galveston, a harbor rapidly increasing in commercial importance. No appropriation for the construction of these works has yet been made.

No appropriation asked for next fiscal year.

DEFENSES OF SAN DIEGO HARBOR.

Fort at San Diego, California, in charge of Col. C. S. Stewart, Corps of Engineers.—This earthwork, situated in rear of Ballast Point, commands the channel at the entrance to the bay and harbor of San Diego.

The first and only appropriation for it was an appropriation of $50,000 for the fiscal year 1873–'74; under it work was commenced in 1873, and considerable progress was made, but in its present unfinished state this battery is utterly worthless for defensive purposes. Its position wholly controls the entrance to the important harbor and bay of San Diego, every vessel going in necessarily passing close to the work.

The embankment of the faces of the battery was raised to the level of the parade, and the concrete masonry of the walls of one service magazine built to the spring of the arch. The watchman in charge of the public property has made the repairs to embankments which have been required.

To complete this work so that it may receive its armament of heavy guns requires the construction of everything above the level of the parade; that is, of parapets, magazines, terre-pleins, breast-height walls, platforms, and communication. It is estimated about $135,000 will be required for these. The plans of the work require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.
No appropriation asked for next fiscal year.

DEFENSES OF SAN FRANCISCO, THE NAVY-YARD AT MARE ISLAND, AND THE ARSENAL AT BENICIA.

Fort Winfield Scott, entrance to San Francisco Harbor, California, in charge of Col. C. S. Stewart, Corps of Engineers.—This casemated work, commenced in 1853, and its exterior earthen barbette batteries, begun in 1870, form the defenses of the south side of the Golden Gate, the entrance to San Francisco Harbor.

The main work is garrisoned.

The Engineer watchman has painted the iron-work of the embrasures.

The disintegration of the mortar in the joints of the scarp and in the soffits of the arches continues, particularly on the faces of the work ex

DEFENSES OF SAN FRANCISCO, THE NAVY-YARD AT MARE ISLAND, AND THE ARSENAL AT BENICIA—continued.

posed to the prevailing summer winds. In general, the casemates are in good condition.

The sea-wall is in good order; the damages to the filling and paving in its rear caused by the extraordinary storm in January last have been repaired, and 234 running feet of bulkhead rebuilt. The apron at the foot of the wall has changed but little during the year.

The magazines are in good condition. The state of the work is much as it has been for several years past.

Earthen barbette batteries exterior to the fort.—Two gun platforms have been taken up for repairs; the roof and ceiling of overseer's quarters have been renewed; repairs made to carpenter's and blacksmith's shops, to the stable and other buildings; also to water-pipes, ramps, drains, and fences. The slopes of part of the parapets and traverses have been mowed, and the exterior of seven of the buildings whitewashed.

Two platforms, in addition to those which are mounted, are ready to receive their guns. Four others have been constructed, but, owing to the settlement of the terre-pleins in deep filling, two of these are not in condition to have the guns mounted. The pintle-blocks for eight platforms are in position, and the concrete foundations for six more have been built. Three positions for heavy guns are ready for platforms, and fourteen more have been begun. Twelve traverse magazines are ready, and sixteen in addition can be used. Twelve timber platforms for heavy mortars are in position. The timber of these is decayed.

To complete the batteries for their armament of heavy guns will require, it is estimated, about $130,000. The plans require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort at Lime Point, San Francisco Harbor, California, in charge of Lieut. Col. G. H. Mendell, Corps of Engineers.—The name Lime Point is given to the northern shore of the entrance to San Francisco. It covers the ground extending from Point Cavallo to Point Bonita, about 4 miles to the westward. It must contain all the fixed defenses on the northern shore of the Golden Gate.

The existing defenses are incomplete, and no work except in the way of repair has been done during the past ten years. Two keepers are employed to care for the batteries, roads, buildings, and fences.

Considerable damage was done to buildings, roads, and fences by a severe storm in January last. These damages have for the most part been repaired, and the remainder will be taken care of during the coming year.

The water supply needs immediate attention, the tank that forms the reservoir having become unserviceable during the year. It is proposed to rebuild it during the coming year. The plans of the batteries require revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

DEFENSES OF SAN FRANCISCO, THE NAVY-YARD AT MARE ISLAND, AND THE ARSENAL AT BENICIA—continued.

Fort on Alcatraz Island, San Francisco Harbor, California, in charge of Lieut. Col. G. H. Mendell, Corps of Engineers.—The position of Alcatraz Island commands the channels leading to San Francisco, and of much of the anchorage ground that might be occupied by an enemy's fleet.

No construction took place during the year. The keeper, with the assistance of prisoners confined on the island, kept the roads, buildings, drains, and batteries in repair, painted and in other ways cared for the torpedoes, and kept up the necessary miscellaneous details of caring for the defenses, 2,100 days' labor having been applied to these purposes.

The condition of the batteries and their armament remain unchanged. Four magazines showed dampness during the wet season, although all are considered serviceable.

No construction has been done in the past ten years, and the defenses are practically in the same condition now as then.

The torpedoes remain unsuitably stored as they were last year. They require and receive special care and attention.

The plan of the work requires revision.

No appropriation having been made, no work was done at this fortification during the last fiscal year beyond its protection, preservation, and repair, as far as was possible with the general appropriation made for this purpose, and no other work is contemplated during the current fiscal year for the same reason.

No appropriation asked for next fiscal year.

Fort Mason, San Francisco Harbor, California, in charge of Col. C. S. Stewart, Corps of Engineers.—During the late civil war two temporary earthen batteries were built on this point.

In the east battery the timber platforms are decayed as well as the wood-work of the magazine, which has caved in. This battery is unserviceable.

Projects for new earthen batteries of heavy guns and mortars for the occupation of this important point in the second line of defense for the bay and harbor of San Francisco have been prepared by the Board of Engineers for the Pacific Coast.

No appropriation was made for the fiscal year ending June 30, 1887.

No appropriation asked for next fiscal year.

Batteries on Angel Island, San Francisco Harbor, California, in charge of Col. C. S. Stewart, Corps of Engineers.—The three earthen batteries on this island were built during the late civil war for temporary use. The timber platforms and the timber magazines are decayed, and nearly all the gun-carriages have been condemned.

The batteries are unserviceable.

Barbette earthen batteries for the heaviest guns have been planned by the Board of Engineers for the Pacific Coast, to occupy the most valuable positions on the island which bear on the channels leading to the upper part of the bay, to the navy-yard at Mare Island, and to the arsenal at Benicia.

No appropriation was made for the fiscal year ending June 30, 1887.

No appropriation asked for next fiscal year.

DEFENSES OF THE COLUMBIA.

Defenses at the mouth of the Columbia River, Oregon, and Washington Territory, in charge of Capt. C. F. Powell, Corps of Engineers.—The defenses consist of Fort Stevens, an inclosed earthwork at Point Adams,

DEFENSES OF THE COLUMBIA—continued.

Oregon, on the south side, and the earthen batteries at Fort Canby, Cape Disappointment, Washington Territory, on the north side.

The works command the channels at the entrance, the ship-channels leading to Astoria, and the anchorage in Baker's Bay under the lee of the cape on the north.

The channels to the river have natural depths of 19 to 24 feet at low water, and a mean rise of tide above this plane of 7½ feet.

These defenses are field works in character; they were built hastily during the late civil war in anticipation of complications with foreign powers. On account of increased penetration of present ordnance, and the decay of the greater part of the wooden platforms and magazine timbers, the works are of little value in their present condition.

Fort Stevens.—Seven gun platforms were rebuilt and minor repairs made about the fort. A new ordnance store-house was erected and work done on other buildings and grounds.

Fort Canby.—Five gun platforms were built at the right battery and shot-beds at the three batteries.

No appropriation was made for the fiscal year ending June 30, 1887.
No appropriation asked for next fiscal year.

THE BOARD OF ENGINEERS.

The Board of Engineers stationed in New York City consisted of Col. James C. Duane, Lieut. Col. Henry L. Abbot, Lieut. Col. Cyrus B. Comstock, Lieut. Col. David C. Houston (since January 20, 1886), Lieut. Col. Walter McFarland (since January 20, 1886), and, when so ordered, the officer in charge of the work under consideration.

During the fiscal year the Board has considered the questions referred to it by the Chief of Engineers and submitted reports thereon, of which the following is a brief summary:

1885, July 11. Relative to the kind of metal for armor plates, in fortifications.

July 17. Upon the future prosecution of the project for the improvement of Nantucket Harbor, and upon location and plan of an eastern jetty.

December 11. Submitting general projects for the defense of New London, Savannah, Charleston, Key West (as a naval station), Mobile, and the entrance to Cape Fear River.

December 11. Upon the question of defense of our lake coasts and cities.

1886, January 9. Upon the question of acquiring North Head, Washington Territory, as a military reservation and the necessity of a battery thereon.

January 21. Upon the subject of the improvement of Galveston Harbor, and submitting plan and estimate therefor.

February 16. Upon plan of Henry A. Peeler for harbor improvement and jetty work.

February 16. Upon plan of Israel P. Williams for the defense of Boston Harbor.

March 1. Upon letter of Captain Bixby relative to a form of foundation for heavy guns, &c.

March 8. Upon designs of Captain Marshall for lock-gates.

March 10. Upon proposition to furnish Howell torpedoes and launching apparatus for experimental practice.

March 10. Upon necessity of the purchase, by the United States, of land adjacent to Fort Hamilton, New York Harbor.

March 16. Upon design of John Ambrose for an "Occult Fort and Moat Battery."

March 23. Upon design of Beverly Kennon for a Counterpoise Battery.

April 19. Upon Senate bill 662, to authorize contracts for steel guns and armor.

April 19. Upon plan of H. F. Knapp for improving Galveston Harbor.

April 20. Upon value of land adjacent to Fort Hamilton, New York Harbor.

April 27. Upon design of Major von Zubovits for a land torpedo.

April 27. Upon proposition of Sims-Edison Electric Torpedo Company to furnish five 2-mile torpedoes.

May 11. Upon suggestions of Captain Marshall relative to maintenance of locks on Fox River.

May 25. Submitting estimate of cost of inaugurating the statue of Liberty Enlightening the World, including electric-light plant.

June 2. Upon question of line of proposed Harlem River improvement, opposite the Ogden estate.

June 22. Upon letter of F. I. Palmer on the subject of improvement of New York Harbor.

In addition to their duties with the Board of Engineers, the individual members have been otherwise engaged as follows:

General Duane has continued in charge of his light-house duties, as engineer of the third district, has served as member of the Board of Visitors to the Engineer School of Application at Willets Point; and on special Board for the examination of officers of Engineers for promotion.

General Abbot remained in command of the Engineer Battalion and Post of Willets Point and Engineer School of Application; also in charge of torpedo experiments and construction of the works of defense at the eastern entrance to New York Harbor until March, 1886; has continued since in charge of certain torpedo experiments; has served throughout the year as member of Board of Visitors for the Engineer School of Application at Willets Point; of Board of Officers and Civilians to examine and report at what ports fortifications or other defenses are most urgently required, &c.; and has served on special Boards for the examination of officers of Engineers for promotion; on bridge over the Ohio River at or near Cairo, Ill.; for trial of pneumatic dynamite torpedo gun.

General Comstock has served throughout the year as member of the Mississippi River Commission; of Board of Visitors for Engineer School of Application at Willets Point; of Board on improvement of the Potomac River near Washington; on further improvement of Cape Fear River, and on special Board for the examination of officers of Engineers for promotion. Since March 15, 1886, has commanded Engineer School of Application, the Engineer Depot and Post of Willets Point, the Engineer Battalion (March 15–April 26, 1886), and in charge of torpedo experiments, of fort at Willets Point, the construction and repair of Fort Schuyler, and as supervising engineer of all expenditures for torpedoes, Engineer Depot, Fort Schuyler, and library of Engineer School of Application, June 8, 1886.

Colonel Houston served as supervising engineer July 1, 1885, to January 20, 1886; as member of the Board of Engineers and of the Board of Visitors for the Engineer School of Application at Willets Point since January 20, 1886; in charge of works of river and harbor improvement, and fortifications, under letters of Chief of Engineers of January 30 and February 5, 1886; in temporary charge of works under charge of Lieutenant-Colonel McFarland; representing the General Government in the erection of the pedestal being built to receive the colossal bronze statue of Liberty Enlightening the World upon Bedloe's Island, New York Harbor, June 7, 1886; and on special Boards, viz: on bridging the Alabama River at Selma, Ala.; for the examination of officers of Engineers for promotion.

Colonel McFarland has continued the various works of river and harbor improvement and of fortifications under his charge; and since January 20, 1886, has served as a member of the Board of Engineers and of the Board of Visitors for the Engineer School of Application at Willets Point; also on special Board on subject of permanent improvement of Delaware River and Bay.

Coast defense.—This subject having been fully discussed in former reports of the Board, further reference to the condition and requirements of our sea-coast fortifications is considered unnecessary.

Torpedo defense.—The act of Congress providing for fortifications, &c., for the fiscal year 1885–'86, provided as follows:

For the purchase of movable submarine torpedoes propelled and controlled by power operated and transmitted from shore stations, as may be recommended by the Board of Engineers of the Army of the United States, and approved by the Secretary of War	$50,000
For improvements, competitive test, and purchase of motors for movable torpedoes	25,000
For purchase of appliances for submarine mines for harbor defense	10,000
For continuation of torpedo experiments and for practical instruction of Engineer troops in the details of the service	20,000

About three-quarters of the whole annual appropriation for torpedo defense was thus again restricted to the purchase and improvement of the Sims torpedo, to which alone the wording of the law is applicable. This torpedo was in an experimental stage, and the year has expired before the results obtained have been such as to warrant the purchasing of large numbers of them for store. Much of this appropriation and still more of that for the preceding year have thus reverted to the Treasury. This money could have been expended to great advantage in providing for the defense of the coast by submarine mines had the language of the law warranted this application. The contract for five Sims's torpedoes under the appropriation for 1884–'85, mentioned in our last annual report, was transferred to that for 1885–'86. Two of the boats have been accepted, and the time for the delivery of the remaining three has been extended until September 30 upon Mr. Sims's application.

In the present condition of the sea-coast defenses our chief reliance in case of war would be upon fixed mines. The number on hand is insignificant, and the essential preparations for operating even those we have are yet to be made. The reasons for a moderate annual expenditure for these objects have been so strongly urged in many former reports of this Board, and have been so fully set forth in the report of the Board ordered last year by Congress to report "at what ports fortifications or other defenses are most urgently required, and the character and kind of defenses best adapted for each, with reference to armament, utilization of torpedoes, mines, or other defensive appliances," that it seems unnecessary to recapitulate them here. The Board therefore presents the following consolidated estimate for the service of torpedoes during the fiscal year 1887–'88.

For the purchase of submarine mining materials to close the channels to our principal sea-ports against the entrance of hostile fleets............	$300,000
For the needful casemates, cable galleries, &c., to render it possible to operate submarine mines in the defense of the principal ports on the Atlantic and Gulf coasts..	200,000
For continuing torpedo experiments and for the practical instruction of Engineer troops in the details of the service	30,000
Making a total of	530,000

The following extracts from General Abbot's report exhibit the progress made in these matters at Willets Point during the first nine months of the past year:

Investigations with new explosives were restricted to determining, by my ring method, described in Professional Papers No. 23 of the Corps of Engineers, certain facts respecting the rack-a-rock to be used at the great Flood Rock explosion. Over one hundred 3-pound charges were fired. They indicated (1) that from 21 to 23 per cent. of nitro-benzol gives rack-a-rock its highest intensity of action; (2) that it is important to have the potassium chlorate dry—2 per cent. of water, replacing an equal weight of the salt, reduced the intensity 5 per cent.; 4 per cent. of water, 10 per cent., and 6 per cent. of water, 19 per cent.; (3) that whether loosely or solidly compacted in a tin can submerged 35 feet under water, and whether detonated by 48 grains of mercuric fulminate (two fuses) or by 24 grains (one fuse) reinforced by a 3-ounce tonite primer, the measured intensity of action remains unchanged, and indicates an explosion of the first order; (4) that the rack-a-rock used at Flood Rock was of marked uniformity—to test this one shot was fired for every 5,000 pounds delivered; and (5) that the mean of over 70 shots, according well with each other, indicates an intensity of action of 108 to 109 per cent. of that of dynamite No. 1 taken as a standard.

In the matter of Sims's movable fish torpedo, work was restricted to testing the new motor made upon my specifications (electrical) at the Edison works, and to certain dock trials and runs to determine what speed it would give the 2-mile boat carrying a charge of 350 pounds. The motor proved to be superior to that made by Mr. Weston in the ratio of 43 to 29. It developed about the same absolute power as that made by Siemens Bros., London, but generated at a much lower armature velocity (700 instead of 990 turns per minute) when working to the best advantage. This is an important merit, because it dispenses with gearing. With a propellor suited to hold the armature at 700 revolutions, about 9 or 10 horse-power can be transmitted through 2 miles of cable without overtaxing its endurance. This probably fixes about 11 miles per hour as the extreme maximum speed which this torpedo can maintain while carrying a 400-pound charge in a full 2-mile run.

Further improvements in the steering relay and magnets have resulted from the trials of the past year; and, by a happy suggestion of Captain Knight, the troublesome double revolving reel for coiling the cable has been rendered unnecessary. The torpedo may now be regarded as perfected in its essential details; and its practical value as a war weapon can probably be estimated with some precision after the trial runs of the five new boats are completed and the detailed reports thereon are submitted to the Board.

On May 14, 1885, a contract was made with Mr. Thomas F. Rowland, Continental Iron Works, Brooklyn, to supply a steam vessel specially designed for planting submarine mines, handling heavy insulated cable, &c. It was accepted on January 4, 1886, after satisfactory trials in which she exhibited over the measured mile a speed of 9.8 miles per hour advancing, and 8.7 miles backing, with the power of causing her sternpost to describe a circumference whose center was at her bow either to starboard or port as desired. She has capacity for carrying all the material of a grand group of twenty-one mines, with the men needed for planting them. Her total cost was $28,000. She was named after Capt. David Bushnell, Corps of Sappers and Miners, Army of the Revolution, who originated modern torpedo warfare.

The following are her principal dimensions: Length on the water line, 75 feet, and on deck 84 feet; beam (over planking), 20 feet 2 inches; depth of hold, 8 feet 9 inches; with bunkers filled with coal (9 tons) and tanks filled with water (8 tons) and in working condition as to boilers and grates, average draft 5 feet 4 inches, corresponding to a displacement of 122 tons; fully loaded, in addition with material for a grand group of twenty-one mines, with twenty men on board, giving a displacement of 145 tons, average draft, 6 feet 2 inches. Her motive power is supplied by a pair of inclined condensing engines of 120 horse-power, with cylinders 14 inches in diameter and 15 inches stroke, geared to a Mallory patent steering apparatus, propeller 5 feet 6 inches in diameter and 10 feet in pitch. The boiler is of the Scotch type, with two furnaces, 36 square feet of grate and 850 square feet of heating surface. The shaft is of forged steel. The hull is of composite type, having iron frames, floors, reverse bars, stringers, &c., and wooden keel, stem, sternpost, deadwood, and planking.

Steering may be by hand, or, if desired, by a pair of oscillating engines with 5-inch cylinders and 5-inch stroke, controlled by a lever in the pilot-house. Another lever enables the wheelman to start, stop, and slow the main engine (it is never reversed); and steam gauges exhibit to him both the pressure and vacuum. Work in the engine-room is therefore reduced to tending the fires and supervising the machinery, the boat being entirely controlled in the pilot-house.

The David Bushnell is fitted with a revolving derrick, supplied with a lifting and falling boom of ample power to handle 6,000 pounds, with a Burton purchase. The mast is of wrought iron and hollow to pass the falls to the barrel of the hoisting engine below. This engine has two cylinders 7 inches in diameter and 6 inches stroke; and is so geared to the rope barrel and to two winches on deck that all may be operated from the deck in unison or either one separately.

The vessel appears to be well suited to the work for which she was designed, and is built in a substantial and thorough manner, very creditable to the constructor, Mr. Rowland, at whose yard, it will be remembered, the original Monitor was built in 1862.

Since being relieved from command at Willets Point, I am conducting a series of experiments here to improve certain details in the firing arrangements of self-acting mines (not under control) and of movable fish torpedoes. Good progress has been made.

The following is from General Comstock's report on torpedo matters for the last three months of the year:

Since taking charge of torpedo experiments and up to June 30, 1886, two of Sims's fish torpedoes have passed the test required under his contract, and have been accepted. His contract has been extended by the honorable the Secretary of War to September 30, 1886, prior to which time he is to deliver three more.

The tests on fish No. 7 occupied from May 20, 1886, to June 17, 1886, in which time ten runs or attempts to run were made, the fish only attaining the required speed of 10 miles per hour for 1¼ miles on the last day. One of the preceding runs was for diving under a spar and for steering, which was satisfactory, except that the cable burned out and stopped the run. Of the other eight runs, two were failures from loose belt on dynamo, the necessary energy to drive the fish thus not being furnished. Three were failures from bad insulation in the interior of the fish, arising from defective work, or, in one case, from water leaking in; two were failures from burns in cable, and one, without accident, failed to give speed.

Fish No. 6 made five runs, or attempts at runs, between June 24 and 29, 1886. At the first trial the steering relay was burned in the fish, the accident arising from a wrong coupling of the wires at the steering-board. At the second run, the dynamo belt slipped, and sufficient energy was not furnished to the fish. At the third run defective insulation caused a burn near the shunt in the steering relay. At the fourth run the required speed of 10 miles an hour for 1¼ miles was obtained. At the fifth run, which was to test steering, the results were satisfactory.

POST OF WILLETS POINT AND ENGINEER SCHOOL OF APPLICATION, U. S. A.

The strength of the command on June 30, 1886, was 21 officers and 351 enlisted men, commanded by Lieut. Col. C. B. Comstock, Corps of Engineers.

The troops stationed at this post are the only ones familiar with fixed torpedo defense, and on them almost entire reliance must be placed in any emergency. The command should therefore be kept at its full strength, and be thoroughly instructed, this being the more necessary from the absence of other effective defenses for our seaports.

Beside being a school for the instruction of officers and men in the complicated details of torpedo defense, advantage is taken of the opportunity to give officers practical instruction in military engineering, electricity, astronomy, surveying, photography, and theoretical instruction in civil engineering.

There is great need of a sufficient water supply, of sewerage, of additional quarters, and of books for the school.

STATEMENT OF FUNDS.

Amount that can be profitably expended in fiscal year 1887-'88:

For water supply	$17,000
For sewerage and plumbing	12,000
For lieutenant's quarters	12,000
For a new barracks for 150 men	35,000
For books, instruments, stationery, clerical services of civilians or enlisted men, and miscellaneous for School of Application	1,000

(See Appendix No. 1.)

BATTALION OF ENGINEERS AND DEPOT AT WILLETS POINT, NEW YORK HARBOR.

On the 30th of June, 1886, the battalion of engineers consisted of 17 commissioned officers, detailed from the Corps of Engineers, and 396 enlisted men, the maximum legal strength being 752 men. The field and staff and band, and Companies A, B, and C, were stationed at Willets Point, New York Harbor; Company D exists only in name, and Company E was stationed at West Point to assist in the instruction of cadets in practical engineering, pontoniering, &c.

The troops at Willets Point receive, store, and issue the public property of the depot and carry out experiments with explosives, electricity as applied to transmission of power, ignition of mines, &c., fixed and movable torpedoes, and other matters connected with practical engineering and torpedo service.

The battalion is equipped and drilled as infantry, in addition to the special duties for which it is organized.

All tools and supplies for sapping, mining, pontoniering, and field fortification, as well as surveying and astronomical instruments for use of officers of the Corps on surveys and works of construction, were stored and issued at the Engineer depot at Willets Point.

The commanding officer of the battalion and depot submits the following estimate of funds needed for the service during the next fiscal year, viz:

For incidental expenses at depot	$7,000
For purchase of materials for instruction of Engineer troops	1,500
For purchase and repairs of instruments	2,500
For an additional building for Engineer models	8,000
Total	19,000

For further information as to the battalion and depot, see report of the officer in command.

(See Appendix No. 2.)

RIVER AND HARBOR IMPROVEMENTS.

These improvements, for which appropriations are made by Congress, constitute a great system, which, although its various parts possess very unequal values, taken as a whole, by extending along our ocean, lake, and gulf coasts and reaching far into the interior, creates safe and easy avenues of trade, leading into each other, that add vast wealth to the country by the facilities they afford to the movement of commerce and the safety they insure to it.

The funds with which these works were prosecuted during the fiscal year ending June 30, 1886, were, owing to the failure of appropriations during the second session of the Forty-eighth Congress, derived mainly from such balances as remained on hand from the appropriations of the act of July 5, 1884, and in many instances these being only sufficient to provide for the care of the public property appertaining to the works, operations were necessarily suspended, to the detriment of the works.

A brief statement taken from the reports of the officers in charge of the several works is given below, setting forth the condition of each improvement; the extent of work performed during the last fiscal year; the amount of money expended; and, in compliance with the provisions of the river and harbor act of March 2, 1867, estimates of the amount that can be profitably expended during the fiscal year ending June 30, 1888, with the probable cost of completion.

Although, as a general rule, regard is necessarily had in the preparation of these estimates to the more intimate acquaintance of the engineer officers in charge with the requirements of each locality, they have been revised and amended in this office, when deemed advisable, having regard to the most economical administration of the works and keeping in view the average of the grants by Congress for each work during the past few years.

The reports of the officers in charge of the various improvements will be found in the Appendix. To these reports special reference should be made whenever detailed information is desired concerning the progress and condition of each work.

The examinations and surveys at localities required and provided for in the river and harbor act of August 5, 1886, have been distributed and assigned to the officers in charge of the several river and harbor districts. They are in progress, and the reports thereon will be submitted from time to time during the ensuing session of Congress as far as received.

Examinations were made during the fiscal year, of such plans and locations as were submitted by parties interested, of bridges proposed to be built over navigable waters under authority of Congress, subject to the approval of the Secretary of War. A brief statement is given below of the action had in such cases. Examinations were also made whenever requested by committees of Congress, of proposed bills authorizing the construction of bridges upon which the views of the War Department were desired. Of bills so examined during the last session of Congress fifteen originated in the Senate and forty-three in the House of Representatives.

A statement is also given of the work accomplished in the removal of wrecks obstructing or endangering navigation, general provision for which is made in the river and harbor act of June 14, 1880, enlarged by provisions of the river and harbor act of August 2, 1882.

ATLANTIC COAST AND GULF OF MEXICO.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATES OF MAINE AND NEW HAMPSHIRE.

Officers in charge, Col. Charles E. Blunt, Corps of Engineers, to February 28, 1886; since which date, Maj. Jared A. Smith, Corps of Engineers. Supervising Engineer, Col. Charles E. Blunt.

1. *Lubec Channel, Maine.*—The present project for improvement of this channel was adopted in December, 1878, and modified in 1883 and 1885,

the object being to give a channel of not less than 275 feet in width and 300 wide at the bends, and a depth of 12 feet at mean low water, or about 8 feet at extreme low tides.

The channel was originally obstructed by bars and shoals, having but 5 feet at mean low water.

In the last fiscal year 5,792 cubic yards of material were removed from the channel by dredging.

The amount expended on this improvement to June 30, 1886, has been $139,000. The resulting channel is 200 feet wide throughout the entire length, and has a width of 278 feet at the lower bend. The entire length is about 2½ miles.

The channel forms part of an important thoroughfare, the only one belonging to the United States by which many places on our eastern frontier can be reached.

The appropriation asked for fiscal year ending June 30, 1888, is for the purpose of completing the channel at its present depth to a width of 275 feet, and 300 feet at the bends.

July 1, 1885, amount available	$3,039 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,039 29
Amount appropriated by act approved August 5, 1886	10,000 00
Amount (estimated) required for completion of existing project	22,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 1.)

2. *Bangor Harbor and Penobscot River, Maine.*—The present project for improvement of this harbor and river was adopted in 1884, being based upon a survey made in 1883. The object of the improvement is to give more room in the harbor of Bangor, by making the channel 100 feet wider, and to straighten and widen the channel at Crosby's Narrows, 3½ miles below.

In the last year the channel was widened 100 feet on the east side for a distance of 2,728 feet, and 11 feet deep at extreme low water.

The total amount expended upon the improvement to June 30, 1886, has been $19,950.68. The resulting channel is 300 feet in width and 11 feet deep for about half a mile in the harbor of Bangor.

The appropriation asked is to complete the widening of the channel in the harbor to 300 feet and to complete the excavation in channel at Crosby's Narrows:

July 1, 1885, amount available	$19,966 34
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	19,917 22
July 1, 1886, amount available,	49 12
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,049 12
Amount (estimated) required for completion of existing project	40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 2.)

3. *Moose-a-bec Bar, Maine.*—The present project for improving the channel over Moose-a-bec Bar was based upon a survey made in 1879, and was adopted in 1881. The object of the improvement was to give

a direct and clear channel having a width of 200 feet over the bar and a depth of 14 feet at mean low water; the length to be dredged was about 1,900 feet. The old channel was indirect, crooked, and obstructed by dangerous ledges.

The entire amount expended upon the improvement to June 30, 1886, has been $29,946.34.

In the last year there were removed from the channel by dredging under contract 23,345 cubic yards of material. The resulting channel covers all that the project contemplated save the removal of a few small ledges, at an estimated cost of $10,000.

The thoroughfare is one of universal use for steamers and sailing vessels of all kinds traversing the coast, and its benefits are general to a large and widely distributed commerce.

July 1, 1885, amount available	$10,027 04
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,973 38
July 1, 1886, amount available	53 66
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,053 66

(See Appendix A 3.)

4. *Belfast Harbor, Maine.*—The project for improving this harbor was adopted in 1876, the object being to enable vessels to arrive and to leave the wharves at all stages of the tide.

No work was done during the last fiscal year.

The total amount expended to June 30, 1886, was $22,193.20.

The resulting channel gives 10 feet in depth to the wharves in the upper part, and 11 to 12 feet in depth to the wharves in the lower part of the harbor.

A small balance of $2,806.80 remains unexpended. With this balance it is proposed to deepen the water as far as possible in the channel opposite Belfast whenever circumstances will favor its being done with advantage and economy.

In the spring of 1886, the wreck of schooner Waldemar was removed from the harbor, under the general act for removing sunken vessels, approved June 14, 1880.

July 1, 1885, amount available	$2,843 05
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	36 25
July 1, 1886, amount available	2,806 80

(See Appendix A 4.)

5. *Rockland Harbor, Maine.*—The present project for improving this harbor was adopted in 1881, the object being to protect the harbor so as to form a refuge and secure anchorage for vessels, and to enable them to land at the wharves in all kinds of weather.

The entrance to the natural harbor is broad and exposed to easterly winds, so that with heavy winds from northeast to southeast the anchorage and wharves had but little protection.

In the last year 39,959 tons of stone have been added to the breakwater from Jameson's Point, making the total length, raised to 5 feet above low water, 1,472 feet.

There has been expended on the work to June 30, 1886, $97,921.99.

The resulting protection to the harbor is already felt, though it is comparatively small to that which will be effected by completing the breakwaters.

The appropriation asked is to be applied to continuing the construction of the breakwaters.

July 1, 1885, amount available	$17,312 79
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	14.390 80
July 1, 1886, amount available	2,921 99
Amount appropriated by act approved August 5, 1886	22,500 00
Amount available for fiscal year ending June 30, 1887	25,421 99
Amount (estimated) required for completion of existing project	427,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 5.)

6. *Portland Harbor, Maine*—The various projects for improving this harbor under successive appropriations have all been completed, save the deepening by dredging of a part of the harbor outside the "Commissioner's line" from Brown's Wharf to Galt's Wharf. The entire work will be completed in two weeks.

In the last fiscal year there has been removed by dredging 19,890 cubic yards, thus giving 17 feet depth of water where formerly only 12 to 16 feet could be obtained.

There has been expended from 1836 to June 30, 1886, a total of $434,582.05.

The object of these improvements has been to give a sufficient depth of water in the main harbor and to afford protection from the sea; also, to a small extent to give a channel of navigable depth in the cove back of the city.

The results thus far are a depth of 21 feet over the lower part of the harbor, and 16 to 17 feet as far up the harbor as to Brown's Wharf; also, a breakwater with light-house at its extemity, and a small channel in the back cove giving 8 feet at mean low water.

The Board of Trade, a meeting of citizens, and the City Council have urged the necessity for further improvements; plans and estimates have been made for a channel of 29 feet depth and 500 feet width to the point of arrival and departure of the largest steamers; also for a channel 300 feet wide and 12 feet deep in the Back Cove.

The necessity for extending the deep water in the harbor below to connect with the deep channel above, and also for extending the breakwater, with estimates of the expense, are submitted by the officer in charge for consideration.

July 1, 1885, amount available		$8,326 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885,	$1,941 37	
July 1, 1886, outstanding liabilities	4,519 92	
		6,461 29
July 1, 1886, amount available		1,865 00
Amount appropriated for harbor by act approved August 5, 1886		30,000 00
Amount available for fiscal year ending June 30, 1887		31,865 00

(See Appendix A 6.)

7. *Kennebunk River, Maine.*—All the projects heretofore adopted for this improvement have been completed. No further improvements are at present contemplated. A small balance remains to the credit of the

work which may be used for any trifling repairs or examinations required. No work has been done in the last fiscal year.

No appropriation is asked.

July 1, 1885, amount available	$336 34
July 1, 1886, amount available	336 34

(See Appendix A 7.)

8. *Breakwater at mouth of Saco River, Maine.*—This breakwater, built between 1869 and 1873, was found by a survey made in 1883 to require repairs and raising to enable it to better effect its object of preventing the encroachment of sand on the channel of the Saco River at the mouth. The estimate for this purpose was $70,000, and $15,000 was appropriated in the act of July 5, 1884.

In the last fiscal year there was placed on the breakwater 7,280 tons of stone and 216 cubic feet of ashlar.

The entire expenditure upon this work previous to June 30, 1886, has been $14,973.64. This has enlarged and completed the breakwater a distance of 510 feet with some stone deposited of an additional distance of 175 feet.

The breakwater alone is not sufficient, in the opinion of the officer in charge, to produce any considerable effect in deepening the channel, and in order to obtain any benefits the jetty opposite the breakwater should be commenced.

The amount required to complete the breakwater is found to be larger than the original estimate owing to the settlement and displacement of stone, and also because the prices by contract have been higher than were anticipated.

The appropriation asked is to be applied to completing the repairs to the old breakwater.

July 1, 1885, amount available	$10,293 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	10,267 24
July 1, 1886, amount available	26 36
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	12,526 36
Amount (estimated) required for completion of existing project	57,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 8.)

9. *Saco River, Maine.*—To comply with the requirements of the river and harbor act of July 5, 1884, a preliminary examination and survey were made of Saco River with the view of extending the improvements in progress at the mouth 5 miles up the river as far as the head of navigation. A report of the results of the survey was transmitted to Congress January 15, 1886, and printed as House Ex. Doc. No. 37, Forty-ninth Congress, first session, which contains an estimate of $50,000 as the amount required to create a continuous channel of 6 feet at low water.

The river and harbor act of August 5, 1886, appropriates $12,500 for this work, and a further sum of $12,500 could be profitably expended thereon during the fiscal year ending June 30, 1888.

(See Appendixes A 9 and A 12.)

10. *Portsmouth Harbor, New Hampshire.*—The present project for improving this harbor was adopted in 1879, the object being to change the

currents so that vessels could more easily navigate the channel and be less in danger of striking upon protruding points and the tops of submerged ledges.

In the last fiscal year there were removed by blasting and submarine work 608 cubic yards of rock from the ledge known as Gangway Rock.

The total expenditure previous to June 30, 1886, was $91,991.28.

As a result the larger portion of Gangway Rock has been removed to a depth of 20 feet at mean low water; there remains of this ledge 632 cubic yards to complete the removal to the same depth. A part of the projecting ledge on the point of Badger's Island has also been removed. The officer in charge recommends that the removal of rock on Badger's Island Point be to a depth of 20 feet.

July 1, 1885, amount available	$15,211 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	15,202 28
July 1, 1886, amount available	8 72
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,008 72
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 10.)

11. *Cocheco River, New Hampshire.*—The present project for improving the channel of the Cocheco River was adopted in 1884; its object is to give a channel having 5 feet depth of water at mean low stages as far as to the Packet Landing.

During the last year 829 cubic yards of rock were removed from the channel. This completes the channel to a depth of 5 feet mean low water and a width of 50 to 60 feet, as far as the Steam-mill wharf.

The entire amount expended in improving the Cocheco River from 1836 to June 30, 1886, has been $150,973.64.

At present numerous large vessels go up the river to Dover, though as the improvements are incomplete the vessels have to be lightered a short distance.

The amount asked is to complete the deepening of the channel to 5 feet, in accordance with the plan adopted.

July 1, 1885, amount available	$9,804 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,792 29
July 1, 1886, amount available	12 12
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,012 12
Amount (estimated) required for completion of existing project	9,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	9,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 11.)

12. *Harbor of refuge at Little Harbor, New Hampshire.*—The river and harbor act of July 5, 1884, made provision for an examination and survey of this harbor with a view to its improvement as a harbor of refuge, and a report thereon was transmitted to Congress and printed as House Ex. Doc. No. 91, Forty-eighth Congress, second session.

The necessity for a harbor of refuge of moderate size at this locality, for the numerous smaller vessels engaged in the commerce and fisheries of this part of the coast, having been made apparent from numerous representations of those interested, this harbor is deemed worthy of improvement to a moderate extent at a cost of, say, $33,000. The river and harbor act of August 5, 1886, appropriates $10,000 for this work.

EXAMINATION AND SURVEY FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF JULY 5, 1884.

It appearing, after preliminary examination, that the locality was worthy of improvement by the General Government, Colonel Blunt was charged with and completed the *survey of Saco River, Maine*, the report on the result of which was transmitted to Congress and printed as House Ex. Doc. No. 37, Forty-ninth Congress, first session.

(See also Appendix A 12.)

IMPROVEMENT OF RIVERS AND HARBORS IN MASSACHUSETTS.

Officers in charge, Maj. Charles W. Raymond, Corps of Engineers, to February 4, 1886, since which date Maj. George L. Gillespie, Corps of Engineers.

1. *Newburyport Harbor, Massachusetts.*—The original depth of water on the bar at the entrance of this harbor was from 5 to 7 feet at mean low water; the mean rise and fall of the tide was 7.7 feet.

The object of the improvement is to create a channel through the bar 1,000 feet wide, with a least depth at mean low water of 17 feet.

The project adopted in 1880 was to build two converging rubble-stone jetties, so located as to give a proper direction to the currents, and thereby produce and maintain the desired result. A rubble-stone apron was also proposed to protect the shore of Plum Island, near the south jetty. The estimated cost of the original project was $365,000. In 1881 a dike to close Plum Island basin was proposed, to cost $10,000. This dike was built in 1883. The project was modified in 1883 by changing the direction of the south jetty, and by building a sand-catch in rear and in prolongation of it, instead of an apron on the beach. The cost of the modified project, including the dike, was estimated to be $375,000.

The total amount expended to June 30, 1885, is $160,131.86; by the expenditure of which the dike across Plum Island basin had been built as far as was then prudent; the north jetty had been built of full section 1,540 feet, and of a partial submerged section 1,100 feet further; the south jetty had been built of full section 1,077 feet, and of a partial submerged section 223 feet further.

During the fiscal year the submerged sections of the north and south jetties were leveled up, and that of the north jetty was extended 35 feet. The sand-catch in rear of the south jetty was repaired. Fifty-two yards of sunken ledge were also removed from the harbor, just inside of Plum Island. A comparative survey made in June, 1886, shows that the main channel had shifted to the southward about 500 feet, and had deepened from 9 feet in 1885 to 12 feet in 1886. This increase in depth and the straightening of the channel are very favorable for the ultimate success of the improvement.

About 700 vessels enter and depart from this port annually. The revenue collected is about $2,000. It is impossible to estimate the prospective value of the improvement.

The officer in charge estimates the amount that can be profitably expended during the next fiscal year at $167,500, which will complete the proposed improvement. By the expenditure of this sum the channel through the bar will probably be deepened to not less than 17 feet at mean low water, enabling the large iron steamers that frequent the port to cross the bar without regard to the tide.

July 1, 1885, amount available	$9,868 14
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,625 68
July 1, 1886, amount available	3,242 46
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	40,742 46
Amount (estimated) required for completion of existing project	167,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix B 1.)

2. *Merrimac River, Massachusetts.*—The original condition of the river channel was very narrow and crooked in several places, and much obstructed by sunken ledges, bowlders, and shoals, especially at the falls, which were more or less bare; while in the lower part of the river below Newburyport there were numerous sunken ledges, crib-works, piers, and wrecks.

The object of the improvement is to clear out, deepen, and straighten the channel of the river from its mouth to the Upper Falls, a distance of 21½ miles.

The project, originally adopted in 1870, was to remove obstructions from the Upper and Lower Falls, remove Gangway Rock, remove wreck of schooner Globe, and remove the "boilers." The cost was estimated to be $69,025. This project was revised and extended in 1874, to include the removal of rocks at Deer Island and at Rock's bridges, and at Little Currier Shoal, so that the channel should have the following depths at high water of ordinary stages of the river: From the mouth to Deer Island Bridge, 16½ feet; from Deer Island Bridge up to Haverhill Bridge, 12 feet; thence to the foot of Mitchell's Falls, 10 feet; thence to the head of the Upper Falls, not less than 4½ feet, with the mill water at Lawrence running. This revised project was estimated to cost $147,000. The tide at the mouth of the river has a mean rise and fall of 7.7 feet, and its influence is felt up to the foot of the Upper Falls.

The amount expended to June 30, 1885, was $169,910.81, and resulted in improving the river channel from its mouth to the head of the Upper Falls, in accordance with the adopted project. On June 30, 1885, the work done was in good order, and showed no deterioration. No operations were in progress during the fiscal year.

To complete the improvement so that the same depth of water which has been obtained through Mitchell's Falls can be carried to Lawrence, additional work will be required at the falls above Haverhill, which is estimated to cost $11,000; and additional improvements are needed in the lower part of the river, which are estimated to cost $11,500, or a total of $22,500.

In completing this work this amount could be expended to advantage during the fiscal year ending June 30, 1883.

About seven hundred vessels enter the river annually, and the customs collected yearly are about $2,000.

It is expected that the completion of the improvement will increase the tonnage of the river, and encourage the erection of new manufactories.

July 1, 1885, amount available	$589 19
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	290 15
July 1, 1886, amount available	299 04
Amount (estimated) required for completion of existing project	22 500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	11 500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 2.)

3. *Scituate Harbor, Massachusetts.*—Previous to the commencement of the improvement this harbor had a low-water area of about 57 acres, over 6 acres of which there was a depth of at least 3 feet at mean low water. It was open to the action of easterly winds.

The object of the improvement is to create a harbor of refuge for vessels approaching Boston from the eastward.

The project, adopted in 1880, is to build two breakwaters (one from "Cedar Point" on the north side of the entrance, and the other from the point of the "first cliff" on the south side), and to deepen by dredging the area inclosed and in front of the entrance.

The estimated cost of the improvement is $290,000.

The mean rise or fall of the tide is 8.9 feet.

The amount expended to June 30, 1885, is $37,108.54, by which the north breakwater had been completed of its full section for a length of 720 feet; a portion of the beach near the junction of Cedar Point and the mainland had been protected by a brush and stone bulkhead; a channel had been dredged 1,600 feet long, 100 feet wide, and 5 feet deep at mean low water and the "deep hole" had been enlarged to a basin 200 by 160 feet, and 7 feet deep at mean low water.

No work was done during the fiscal year ending June 30, 1886. The work remains in good order, and essentially unchanged.

The officer in charge reports that the amount that can be profitably expended during the fiscal year ending June 30, 1888, is $100,000, with which it is proposed by him to continue the approved project, as follows:

Build the south breakwater; remove Harbor Rocks; and enlarge the basin to 8 acres and the channel to 150 feet wide, both 10 feet deep at mean low water.

About one hundred and twenty-five vessels seek this port annually, and the money value of the resultant commerce is estimated to be about $50,000.

The benefit to be expected from this improvement cannot be estimated until after its completion. No local improvement of commerce is expected, and the value of such a harbor of refuge is entirely dependent on the accidents of the weather.

July 1, 1885, amount available	$391 46
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	225 86
July 1, 1886, amount available	165 60
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,165 60

Amount (estimated) required for completion of existing project........ 242,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix B 3.)

4. *Boston Harbor, Massachusetts.*—The original condition of this harbor was that its bluffs and headlands were exposed to the action of the sea, and its main channel was in places but 100 feet wide and 18 feet deep at mean low water.

The object of the improvement is:

First. To preserve the harbor by protecting the islands and headlands; and

Second. To improve it by widening, deepening, and straightening the channels.

The projects adopted for this purpose since 1866 have been mainly in accordance with the recommendations of the United States Commissioners, whose labors terminated during that year.

The works of preservation consist of sea-walls, aprons, jetties, &c., which protect the shores, prevent wash into the channels, control tidal scour, and preserve the full height of anchorage shelter.

Such have been built or repaired at Point Allerton and the islands of Great Brewster, Lovell's, Gallop's, Long, Deer, Rainsford, George's, and Castle.

The works of improvement have been by dredging and blasting, by which means the main ship-channel is now at least 600 feet wide and 23 feet deep at mean low water; and the following tributary channels have widths and depths as stated:

1. Charles River; its channel originally crooked and but 50 feet wide and 3½ feet deep, is now 80 feet wide and 6 feet deep at mean low water, from its mouth to Arsenal Street Bridge, a distance of 7¼ miles; while up to Western Avenue Bridge, more than half of this distance, 7 feet draught can be carried at mean low water in a channel 200 feet wide.

2. Hingham Harbor; its channel originally 30 feet wide and 4 feet deep, has been enlarged to 100 feet wide and 8 feet deep at mean low water.

3. Nantasket Beach Channel; originally 50 feet wide and 6½ feet deep, is now 100 feet wide and 9½ feet deep at mean low water.

4. The channel between Nix's Mate Shoal and Long Island has been deepened from 4½ feet to 12 feet at mean low water, and widened from about 50 feet to 200 feet.

The mean rise or fall of the tide is 9.8 feet.

The amount expended to June 30, 1885, was $1,598,971.01, and at that date all the completed works of preservation or improvement were in good order with the exception of some minor repairs which the sea-walls required.

During the fiscal year some immediately necessary repairs were made to the Deer Island sea-walls at a cost of about $150, and a hydrographic urvey of a portion of the lower harbor was made, and the notes partly lotted.

The river and harbor act of August 5, 1886, appropriates $56,250 for oston Harbor, and the officer in charge reports that during the fiscal ear ending June 30, 1888, $264,000 additional could be spent to ad-antage in repairing and extending the sea-walls at Point Allerton, reat Brewster, George's, Lovell's, Deer, Long, and Castle islands; in uilding new sea-walls at Deer and Governor's islands; in widening e main ship-channel at the upper and lower middles to 800 feet, and making surveys on which to base additional improvements.

About 2,500 vessels annually enter from, and the same number clear for, foreign ports. The duties collected during the fiscal year ending June 30, 1886, were $21,079,311.36.

The special benefits to be derived from the proposed expenditure are additional safety and convenience to the commerce of this important port, from which is derived so large a part of the national revenue.

July 1, 1885, amount available		$8,528 99
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,537 58	
July 1, 1886, outstanding liabilities	15 00	
		4,552 58
July 1, 1886, amount available		3,976 41
Amount appropriated by act approved August 5, 1886		56,250 00
Amount available for fiscal year ending June 30, 1887		60,226 41
Amount (estimated) required for completion of existing project		263,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		264,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix B 4.)

5. *Plymouth Harbor, Massachusetts.*—The original condition of this harbor was that Long Beach was rapidly being worn away by storms, and the main ship-channel to the town wharves had but 6 inches of water at mean low tide.

The object of the improvement is to protect and preserve Long Beach and to deepen and widen the channels of approach to the town wharves.

The preservation of Long Beach has been carefully attended to for many years, as the existence of the harbor depends on it. From the nature of the work it can at no time be considered completed.

The project for the improvement of the channel was originally adopted in 1875. It proposed to straighten, deepen, and widen the channel, so that it would be 2,286 feet long, 100 feet wide, and 6 feet deep at mean low water. This was estimated to cost $28,000. This project was modified in 1877 so as to include the dredging of a basin 866 feet long, 15 feet wide, and 8 feet deep at mean low water in front of the town wharves. This modified project was estimated to cost $41,500. Th project was again modified in 1884, when it was proposed to dredge th channel to 9 feet, widen it to 150 feet, and round off its junctions witl the main channel and basin. In 1885 it was proposed to deepen th basin to 9 feet. The project of 1884 was estimated to cost $27,000, an that of 1885 $22,500.

The tides rise and fall a mean distance of 9.3 feet.

The amount expended to June 30, 1885, was, for beach protection	$70,329 7
For dredging	35,152 7
Total	105,482 5

By the expenditure of which the beach was in good order; the channel was 90 feet wide and 9 feet deep, with rounded junctions with th basin and main channel, and the basin was 7 feet deep. During th fiscal year Long Beach was repaired at its southern end. Brush an stone bulkheads were built, which filled breaches made in the beac during the winter of 1885–'86. They aggregated 476 feet long, with 2 jetties each 15 feet long. The beach is now in good order, as is th dredged channel and basin.

Twenty-three hundred vessels sought this port during the fiscal yea carrying about 43,000 tons; and some 45,000 passengers were lande from steamers, packets, &c.

The benefit to be expected from the completion of this improvement is a more convenient navigation of the improved channel and greater facilities in docking vessels.

July 1, 1885, amount available		$3,317 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,900 63	
July 1, 1886, outstanding liabilities	357 18	
		2,257 81
July 1, 1886, amount available		1,059 69
Amount appropriated by act approved August 5, 1886		6,000 00
Amount available for fiscal year ending June 30, 1887		7,059 69
Amount (estimated) required for completion of existing project		15,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix B 5.)

6. *Provincetown Harbor, Massachusetts.*—This important harbor of refuge depends for its existence on the preservation of the low sandy beaches inclosing it. The harbor itself is capacious and deep, with convenient approaches and good holding ground, and the expenditures made for it are entirely for its preservation, which from the nature of the work can at no time be considered completed.

The projects adopted for the repair and preservation of the beaches consist of detached bulkheads of wood and stone, jetties of wood and brush, dikes, sand-catches, and the extensive planting of beach grass, all for the sole purpose of preventing or arresting the movement of the sand. They have been remarkably successful.

The tides have an average rise and fall of 9.2 feet.

The amount expended to June 30, 1885, was $135,924.59, and the works of preservation were in good order.

No operations were in progress during the fiscal year.

During the year ending June 30, 1888, certain additional works of preservation and extensions of the old ones are needed, which it is estimated will cost $90,000, all of which could be advantageously expended during that year. The most important of these new works are a dike across House Point Island flats, estimated to cost $78,000, and the strengthening of the Long Point breakwater at a cost of $5,600.

About seven thousand vessels frequent this harbor annually, carrying cargoes of an estimated value of $18,500,000.

The special benefit to be derived from the proposed expenditure is the preservation of an important harbor of refuge.

July 1, 1885, amount available	$553 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	549 31
July 1, 1886, amount available	4 54
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,004 54
Amount (estimated) required for completion of existing project	90,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	45,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 6.)

7. *Lynn Harbor, Massachusetts.*—The entrance channels of this harbor were originally narrow and crooked, with but 6 feet depth at mean low water, the greater part of the harbor was bare at low water.

The object of the improvement is to obtain an increased depth of water, and a more direct and wider channel of approach to the city wharves.

The project was adopted in 1884. It proposes the excavation of a lower channel, 200 feet wide and 10 feet deep at mean low water, from a point near and east of the White Rocks to deep water opposite Little Nahant, a distance of 3,610 feet; and also an upper channel 6,450 feet long, with the same width and depth, extending from deep water opposite Sand Point to the Lynn Harbor line. It is supposed that the upper channel will require occasional dredging. To aid in keeping the lower channel open a training-wall is proposed from high-water line at Little Nahant, if experience shows it to be necessary.

The cost of this improvement was originally estimated to be $145,000. This estimate was revised in 1885, and then made $157,000.

The mean rise or fall of the tides is 9.3 feet. The amount expended to June 30, 1885, was $50,209.06, by which the lower channel had been dredged as proposed, and the upper channel had been dredged for its full length and depth, but only 100 feet wide. No work had been done on the training-wall.

No operations were in progress during the fiscal year ending June 30, 1886, and the work remains essentially unaltered; some slight decrease in width of channel is noticed, owing to the falling in of the side slopes, or to injuries caused by vessels getting aground.

During the fiscal year ending June 30, 1888, $25,000 could be expended to advantage in repairing the upper channel and in extending its width to the full proposed limit.

About four hundred and fifty vessels annually frequent this port, and the annual commerce amounts to about $775,000. The benefit to be expected from the completion of this improvement is a more convenient and safe navigation of the improved channels.

July 1, 1885, amount available	$9,790 94
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,755 85
July 1, 1886, amount available	7,035 09
Amount appropriated by act approved August 5, 1886	6,000 00
Amount available for fiscal year ending June 30, 1887	13,035 09
Amount (estimated) required for completion of existing project	91,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix B 7.)

8. *Malden River, Massachusetts.*—Previous to improvement the channel of this river was narrow and crooked, and had barely 7 feet of water at mean high tide.

The object of the improvement is to increase the width and depth of the channel from its mouth to the second draw-bridge in Malden.

The project, originally adopted in 1880, was to dredge a channel, 100 feet wide and 12 feet deep at mean high water, up to the second draw-bridge, with two cut-offs, one near the mouth of the river and one half a mile above it. The cost of this project was estimated to be $35,000. This project was modified in 1882, when it was proposed to dredge the natural channel of the river 100 feet wide up to the draw-bridge in Malden, and 75 feet wide thence to the second draw-bridge near the rubber works; the cost of the modified project was originally estimated at $40,000, which sum was increased in 1885 to $47,000.

The mean rise and fall of the tides at the mouth of the river is 9.8 feet.

The total amount expended to June 30, 1885, was $10,000, by which 1¼ miles of the natural channel of the river, from its mouth up, had been improved so that it had a least width of 50 feet (70 feet at turns) and a depth of 12 feet at mean high water.

No work was done during the fiscal year ending June 30, 1886.

Thirty-seven thousand dollars could be expended to advantage during the fiscal year ending June 30, 1888, in completing the amended project.

About one hundred vessels enter this river annually, and their cargoes are valued at about $75,000.

It is expected that the completion of the improvement will increase the tonnage of the river, and encourage the building of new manufactories.

Amount (estimated) required for completion of existing project	$37,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 8.)

9. *Harbor of refuge at Sandy Bay, Cape Ann, Massachusetts.*—This bay, at the northeastern extremity of Cape Ann, Massachusetts, is open to northerly and easterly winds, but is perfectly covered on the west and south. It is spacious, easy of access, very deep, and perfectly free from obstructions.

The projected improvement contemplates the construction of a "national harbor of refuge, of the first class."

No definite project for this improvement has been adopted. Preliminary estimates for it vary from $4,000,000 to $5,000,000, and a large additional sum will be needed for the lighting, buoying, and defense of the harbor when completed.

The rise or fall of the tide is 9 feet.

The amount expended on this improvement to June 30, 1885, was $4,340.03, by which surveys, examinations, and preliminary projects were made.

During the fiscal year ending June 30, 1886, $37,842.54 were expended in depositing 49,762 tons of rubble-stone on the line of the proposed breakwater, and in preparing to mark the initial point of the breakwater with a submerged pier, surmounted by an iron spindle.

The rubble-stone deposited will form a mound (the base of the proposed breakwater) 40 feet wide on top, at a level 22 feet below mean low water, and the funds available will build about 1,200 feet of this mound.

The officer in charge estimates that during the year ending June 30, 1888, $500,000 could be expended to advantage in extending the submerged mound for the breakwater foundation.

The special benefit to be derived from the proposed improvement is the creation of a first-class harbor of refuge on this exposed, much-frequented coast.

July 1, 1885, amount available		$95,659 97
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$25,284 80	
July 1, 1886, outstanding liabilities	12,557 74	
		37,842 54
July 1, 1886, amount available		57,817 43
Amount appropriated by act approved August 5, 1886		100,000 00
Amount available for fiscal year ending June 30, 1887		157,817 43

Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 9.)

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

Officer in charge, Lieut. Col. George H. Elliot, Corps of Engineers.

1. *Harbor of refuge at Hyannis, Massachusetts.*—This harbor lies on the south shore of Cape Cod, about 15 miles to the westward of the heel of the cape, and is an important harbor of refuge.

Before improvement it was an open roadstead exposed to southerly storms.

In the years 1827–'38 a breakwater of riprap granite, 1,170 feet long, was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. It was not as strongly built as we would build a breakwater in a locality of like exposure, and in the years 1852–'82 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water inside the breakwater is insufficient for many vessels that seek the harbor for refuge, and the river and harbor act of July 5, 1884, provided for a preliminary examination and survey of the harbor, with a view of deepening it. The reports in the case, with a plat and an estimate of the cost ($45,743.20), were printed in House Ex. Doc. No. 96, Forty-eighth Congress, second session.

The commencement of this work has been approved by Congress, making an appropriation of $10,000 therefor in the act of August 5, 1886.

No work has been in progress during the last fiscal year. The amount expended on this work has been $123,276.77, and the breakwater has been completed according to the original project and the subsequent plans for strengthening it.

The execution of the project before referred to, of deepening the anchorage area inside the breakwater, will be commenced at the eastern end of the anchorage, and the full width of the area proposed to be deepened will be carried to the westward as far as the appropriation of August 5, 1886, will allow.

July 1, 1885, amount available	$105 48
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	24 67
July 1, 1886, amount available	80 81
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,080 81
Amount (estimated) required for completion of existing project	35,662 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 1.)

2. *Harbor of refuge at Nantucket, Massachusetts.*—This harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the other (the north) side of Nantucket Sound, the navigation of which is intricate and dangerous by reason of numerous shoals. Nantucket Harbor has deep water inside, and the object of the improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod, estimated to be fifty thousand annually. In the memorial to Congress on which the first appropriation for this harbor was based it was stated that more than five hundred vessels had been wrecked in the vicinity of the island.

Before the commencement of the present works there was a shoal about 1½ miles in width outside the entrance, through which shoal the channel or line of best water was only about 6 feet deep and very crooked and subject to changes in location.

The present approved project is to construct jetties of riprap stone projecting from either side of the present entrance to the harbor for the purpose of concentrating the strength of the tidal currents, and excavating a channel of 15 feet depth by scour, and at the places where the full depth required will not be reached by this means to complete the work by dredging.

The amount expended on this project up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $100,211.25, and the result was the construction of the west jetty to a point 3,955 feet from the shore.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $5,620.87. The east jetty was commenced and fully completed to a distance of 120 feet from the initial point on the shore, and the foundation was laid and the jetty partially completed for an additional distance of 100 feet.

Although but little if any effect had been expected before the two jetties should be extended until they should become parallel and contract the channel to the width contemplated, 1,000 feet, it was found in a recent survey that on a line from Brant Point to the present end of the west jetty the least depth of water was considerably greater than at the time of the previous survey, and vessels have less difficulty in entering and leaving the harbor than formerly.

The work required to be done to complete the existing project is the completion of the east and west jetties and the excavation by dredging of so much of the channel as will not be excavated by tidal scour.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the extension as far as possible of the east jetty.

July 1, 1885, amount available		$9,788 75
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,048 81	
July 1, 1886, outstanding liabilities	2,572 06	
		5,620 87
July 1, 1886, amount available		4,167 88
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		19,167 88
Amount (estimated) required for completion of existing project		250,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C 2.)

3. *Wood's Holl Harbor, Massachusetts.*—This harbor is on the north side of Vineyard Sound, and is divided into Great Harbor and Little Harbor. The name "Wood's Holl" is also applied to the adjoining strait which connects Vineyard Sound with Buzzard's Bay. The site of the works now under contruction is Great Harbor, Wood's Holl.

Before improvement the site of the present works was a submerged point of land extending from the shore of the harbor.

The adopted project for the improvement of Great Harbor, Wood's Holl, was for the construction of retaining-walls on the shore, a hollow pier and wharves for the use of the United States Fish Commission and to serve also as a coaling station for vessels of the Revenue Marine and other branches of the public service, and as a harbor of refuge.

The amount expended on these works to June 30, 1885, including liabilities outstanding at that date, was $77,842.66. The retaining and pier walls, and the dredging of the interior of the hollow pier, and the berths for public vessels, had been completed, and the coal, the west, and the cross wharves had been essentially completed.

For want of funds no work has been in progress during the last fiscal year.

The work required for the completion of the project for the improvement of Great Harbor, Wood's Holl, is the construction of the south and east wharves.

In addition to the above there is to be removed a large rock (estimated at 22 tons) from the strait of Wood's Holl.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the construction of the south and east wharves, and the removal of the dangerous rock in the strait of Wood's Holl, just referred to.

July 1, 1885, amount available	$64 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	17 05
July 1, 1886, amount available	46 95
Amount appropriated by act approved August 5, 1886	14,500 00
Amount available for fiscal year ending June 30, 1887	14,546 95

(See Appendix C 3.)

4. *Westport Harbor, Massachusetts.*—This harbor is an estuary of a bay lying between Narragansett Bay, Rhode Island, and Buzzard's Bay, Massachusetts. This is a new work, and no appropriation had been made for it until, by act approved August 5, 1886, Congress appropriated $1,000 "for sand fence."

A report of December 12, 1878, on a survey made in accordance with section 2 of the act of June 18, 1878, stated that "the wearing of Horse Neck Point" (on the north side of the entrance) "could be prevented by small sand-catch jetties, and these could be gradually prolonged so as to narrow the space opposite, and increase the average depth" (of the channel), and named $1,000 as the amount that could reasonably be expended in this way. It is supposed that the sum appropriated by the act of August 5, 1886, is intended for the construction of the sand-catch jetties recommended, and the funds will be expended accordingly.

Amount appropriated by act approved August 5, 1886	$1,000 00

(See Appendix C 4.

5. *Wareham Harbor, Massachusetts.*—This harbor is an estuary at the head of Buzzard's Bay, The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham, the industries of which and of several towns in the vicinity with which it is connected by rail, are chiefly the manufactures of iron, and depend largely on transportation by water of the material used therein. The commerce of Wareham is carried on in sailing vessels, and the channel

is to be made a beating channel for such vessels. Another object of the improvement is the raising of Long Beach, over which the sands from the bay were washed into the harbor.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water in a narrow and very crooked channel. Long Beach, a narrow sand-spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

The original approved project of 1871 for the improvement, and its subsequent modifications, provides for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet with the same depth—10 feet—as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there, in order to prevent the filling of the improved channel above by material abraded from the beach.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $56,467.43, and the result was a channel through and above the upper bar to the wharves with a width of not less than 100 feet and a depth of 10 feet at mean low water. A large part of the work on the lower reaches of the channel had been done, and the river opposite the wharves had been deepened to 9 feet below mean low water. Long Beach was raised above high-water storm tides, except in a few places, so that the major part of the wash of sand into the improved channel inside the beach had been stopped.

The amount expended during the last fiscal year was $8,485.21. The channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and about one-half of the first reach below the wharves was excavated to its full depth of 10 feet below mean low water. This reach includes the heaviest cutting in the entire improvement. The ruling depth of the approaches to Wareham has now been increased from 7 to 9 feet, and the channel has been greatly widened in all the reaches, especially in the main reach below the wharves. Vessels of larger draught can be carried to Wareham than formerly, and the increase in width of channel is already a great help to all vessels in beating in and out of the harbor.

The work required to complete the existing project is the excavation of the channel to its full width and depth from the point to which it was carried by the last contract down to the deep water above Long Beach. There will also be required the expenditure of a few hundred dollars more in the further building up of Long Beach.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to carrying on the work according to the approved project as far as the funds will admit.

July 1, 1885, amount available	$8,532 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,485 21
July 1, 1886, amount available	47 46
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,047 46

Amount (estimated) required for completion of existing project........	$4,050 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,050 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 5.)

6. *Taunton River, Massachusetts.*—This river rises in Norfolk County, Massachusetts, and empties into Mount Hope Bay, a name given to that part of Narragansett Bay lying mainly in Massachusetts. It is about 44 miles in length, measured along its course.

The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quantities of coal, iron, clay, moldings, sand, and other heavy articles for its manufactures, depending largely on water transportation, so that vessels of 11 feet draught can reach the city at high water.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

The approved project of 1871, and its subsequent modification, provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to the Ship Yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the Ship Yard down to and through the Needles and Briggs' Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crosses the bottom of the river at Peter's Point, and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton were to be removed.

The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $134,470.44.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the Ship Yard, on account of interfering with private property, and that on account of the hardness and depth of the material at the sides the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge had been completed. The major part of the dredging below the bridge had been done, but this part of the channel still lacked in width at some places. The channel had been cleared of bowlders from Taunton down to Berkley Bridge. The work of uncovering the ledge at Peter's Point preparatory to its removal had been commenced.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $2,917.95 All of the bowlders and gravel overlying the ledge at Peter's Point within the lines of the proposed channel have been removed; the work of blasting the ledge has been completed; the major part of the broken rock has been removed, and the half-tide dam between Reuben's Island and the west shore of the river, constructed with the view of accelerating the current in the dredged channel below, and preventing deposits, has been essentially completed. The ruling depth of water in the river has now been increased from 5 to 11 feet at mean high water, and vessels of 11 feet draught can now reach Taunton, at the head of navigation.

There remains to be done to complete the existing project the completion of the removal of the ledge at Peter's Point; the completion of the dredging of the channel between Berkley Bridge and Dighton, and widening and deepening at a few points above the bridge; all of which it is proposed to finish in the next fiscal year if the funds now available be sufficient, as hoped for.

July 1, 1885, amount available		$22,529 56
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,130 46	
July 1, 1886, outstanding liabilities	787 49	
		2,917 95
July 1, 1886, amount available		19,611 61

(See Appendix C 6.)

7. *Pawtucket River, Rhode Island.*—The navigable part of the Pawtucket (or Seekonk) River, an arm of Providence River, extends from Providence to Pawtucket, a city which has a population of about 23,000 and extensive manufactures depending largely on water transportation. The object of the improvement is to widen and deepen the channel leading to Pawtucket, so that vessels of 12 feet draught can reach that city at mean low water.

Before improvement the channel in the river had a ruling depth of about 5 feet at mean low water.

The original project, as modified in 1883, provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Company's Wharf at Pawtucket; thence, the deepening by blasting of the channel through the ledge to Pawtucket Bridge to the same depth and 40 feet wide.

The amount expended to June 30, 1885, was $52,718.44. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water. A contract had been made for deepening and widening this channel according to the modified plan of 1883, but the work had not been commenced.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $49,241.02. The new channel, 12 feet deep and 100 feet wide, with enlargements at the bends, has been carried from its mouth at the deep water just above Red Bridge, a distance of about 8,740 feet, or to a point about 1,000 feet above a line drawn from Bucklin Island to Swan Point Wharf. A ruling depth of about 6 feet can be carried from the upper end of the present work to Pawtucket.

The work yet to be done is to excavate, by dredging, the channel 12 feet deep and 100 feet wide from the point to which the last contract carried it to a point opposite Grant & Company's Wharf; and from thence to Pawtucket Bridge to deepen the channel through the ledge to the same depth with a width of 40 feet.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the excavation, by dredging, of the upper reaches of the new channel, and, if the funds will admit, to the commencement of the work on the ledge which lies in the channel off Pawtucket.

July 1, 1885, amount available		$49,287 52
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$49,217 27	
July 1, 1886, outstanding liabilities	23 75	
		49,241 02
July 1, 1886, amount available		46 50
Amount appropriated by act approved August 5, 1886		30,000 00
Amount available for fiscal year ending June 30, 1887		30,046 50

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

Officer in charge, Lieut. Col. George H. Elliot, Corps of Engineers.

1. *Harbor of refuge at Hyannis, Massachusetts.*—This harbor lies on the south shore of Cape Cod, about 15 miles to the westward of the heel of the cape, and is an important harbor of refuge.

Before improvement it was an open roadstead exposed to southerly storms.

In the years 1827-'38 a breakwater of riprap granite, 1,170 feet long, was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. It was not as strongly built as we would build a breakwater in a locality of like exposure, and in the years 1852-'82 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water inside the breakwater is insufficient for many vessels that seek the harbor for refuge, and the river and harbor act of July 5, 1884, provided for a preliminary examination and survey of the harbor, with a view of deepening it. The reports in the case, with a plat and an estimate of the cost ($45,743.20), were printed in House Ex. Doc. No. 96, Forty-eighth Congress, second session.

The commencement of this work has been approved by Congress, making an appropriation of $10,000 therefor in the act of August 5, 1886.

No work has been in progress during the last fiscal year. The amount expended on this work has been $123,276.77, and the breakwater has been completed according to the original project and the subsequent plans for strengthening it.

The execution of the project before referred to, of deepening the anchorage area inside the breakwater, will be commenced at the eastern end of the anchorage, and the full width of the area proposed to be deepened will be carried to the westward as far as the appropriation of August 5, 1886, will allow.

July 1, 1885, amount available	$105 48
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	24 67
July 1, 1886, amount available	80 81
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,080 81
Amount (estimated) required for completion of existing project	35,662 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 1.)

2. *Harbor of refuge at Nantucket, Massachusetts.*—This harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the other (the north) side of Nantucket Sound, the navigation of which is intricate and dangerous by reason of numerous shoals. Nantucket Harbor has deep water inside, and the object of the improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod, estimated to be fifty thousand annually. In the memorial to Congress on which the first appropriation for this harbor was based it was stated that more than five hundred vessels had been wrecked in the vicinity of the island.

Before the commencement of the present works there was a shoal about 1½ miles in width outside the entrance, through which shoal the channel or line of best water was only about 6 feet deep and very crooked and subject to changes in location.

The present approved project is to construct jetties of riprap stone projecting from either side of the present entrance to the harbor for the purpose of concentrating the strength of the tidal currents, and excavating a channel of 15 feet depth by scour, and at the places where the full depth required will not be reached by this means to complete the work by dredging.

The amount expended on this project up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $100,211.25, and the result was the construction of the west jetty to a point 3,955 feet from the shore.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $5,620.87. The east jetty was commenced and fully completed to a distance of 120 feet from the initial point on the shore, and the foundation was laid and the jetty partially completed for an additional distance of 100 feet.

Although but little if any effect had been expected before the two jetties should be extended until they should become parallel and contract the channel to the width contemplated, 1,000 feet, it was found in a recent survey that on a line from Brant Point to the present end of the west jetty the least depth of water was considerably greater than at the time of the previous survey, and vessels have less difficulty in entering and leaving the harbor than formerly.

The work required to be done to complete the existing project is the completion of the east and west jetties and the excavation by dredging of so much of the channel as will not be excavated by tidal scour.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the extension as far as possible of the east jetty.

July 1, 1885, amount available		$9,788 75
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,048 81	
July 1, 1886, outstanding liabilities	2,572 06	
		5,620 87
July 1, 1886, amount available		4,167 88
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		19,167 88
Amount (estimated) required for completion of existing project		250,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C 2.)

3. *Wood's Holl Harbor, Massachusetts.*—This harbor is on the north side of Vineyard Sound, and is divided into Great Harbor and Little Harbor. The name "Wood's Holl" is also applied to the adjoining strait which connects Vineyard Sound with Buzzard's Bay. The site of the works now under contruction is Great Harbor, Wood's Holl.

Before improvement the site of the present works was a submerged point of land extending from the shore of the harbor.

The adopted project for the improvement of Great Harbor, Wood's Holl, was for the construction of retaining-walls on the shore, a hollow pier and wharves for the use of the United States Fish Commission and to serve also as a coaling station for vessels of the Revenue Marine and other branches of the public service, and as a harbor of refuge.

The amount expended on these works to June 30, 1885, including liabilities outstanding at that date, was $77,842.66. The retaining and pier walls, and the dredging of the interior of the hollow pier, and the berths for public vessels, had been completed, and the coal, the west, and the cross wharves had been essentially completed.

For want of funds no work has been in progress during the last fiscal year.

The work required for the completion of the project for the improvement of Great Harbor, Wood's Holl, is the construction of the south and east wharves.

In addition to the above there is to be removed a large rock (estimated at 22 tons) from the strait of Wood's Holl.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the construction of the south and east wharves, and the removal of the dangerous rock in the strait of Wood's Holl, just referred to.

July 1, 1885, amount available	$64 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	17 05
July 1, 1886, amount available	46 95
Amount appropriated by act approved August 5, 1886	14,500 00
Amount available for fiscal year ending June 30, 1887	14,546 95

(See Appendix C 3.)

4. *Westport Harbor, Massachusetts.*—This harbor is an estuary of a bay lying between Narragansett Bay, Rhode Island, and Buzzard's Bay, Massachusetts. This is a new work, and no appropriation had been made for it until, by act approved August 5, 1886, Congress appropriated $1,000 "for sand fence."

A report of December 12, 1878, on a survey made in accordance with section 2 of the act of June 18, 1878, stated that "the wearing of Horse Neck Point" (on the north side of the entrance) "could be prevented by small sand-catch jetties, and these could be gradually prolonged so as to narrow the space opposite, and increase the average depth" (of the channel), and named $1,000 as the amount that could reasonably be expended in this way. It is supposed that the sum appropriated by the act of August 5, 1886, is intended for the construction of the sand-catch jetties recommended, and the funds will be expended accordingly.

Amount appropriated by act approved August 5, 1886	$1,000 00

(See Appendix C 4.

5. *Wareham Harbor, Massachusetts.*—This harbor is an estuary at the head of Buzzard's Bay. The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham, the industries of which and of several towns in the vicinity with which it is connected by rail, are chiefly the manufactures of iron, and depend largely on transportation by water of the material used therein. The commerce of Wareham is carried on in sailing vessels, and the channel

is to be made a beating channel for such vessels. Another object of the improvement is the raising of Long Beach, over which the sands from the bay were washed into the harbor.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water in a narrow and very crooked channel. Long Beach, a narrow sand-spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

The original approved project of 1871 for the improvement, and its subsequent modifications, provides for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet with the same depth—10 feet—as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there, in order to prevent the filling of the improved channel above by material abraded from the beach.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $56,467.43, and the result was a channel through and above the upper bar to the wharves with a width of not less than 100 feet and a depth of 10 feet at mean low water. A large part of the work on the lower reaches of the channel had been done, and the river opposite the wharves had been deepened to 9 feet below mean low water. Long Beach was raised above high-water storm tides, except in a few places, so that the major part of the wash of sand into the improved channel inside the beach had been stopped.

The amount expended during the last fiscal year was $8,485.21. The channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and about one-half of the first reach below the wharves was excavated to its full depth of 10 feet below mean low water. This reach includes the heaviest cutting in the entire improvement. The ruling depth of the approaches to Wareham has now been increased from 7 to 9 feet, and the channel has been greatly widened in all the reaches, especially in the main reach below the wharves. Vessels of larger draught can be carried to Wareham than formerly, and the increase in width of channel is already a great help to all vessels in beating in and out of the harbor.

The work required to complete the existing project is the excavation of the channel to its full width and depth from the point to which it was carried by the last contract down to the deep water above Long Beach. There will also be required the expenditure of a few hundred dollars more in the further building up of Long Beach.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to carrying on the work according to the approved project as far as the funds will admit.

July 1, 1885, amount available	$8,532 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,485 21
July 1, 1886, amount available	47 46
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,047 46

Amount (estimated) required for completion of existing project........	$4,050 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,050 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 5.)

6. *Taunton River, Massachusetts.*—This river rises in Norfolk County, Massachusetts, and empties into Mount Hope Bay, a name given to that part of Narragansett Bay lying mainly in Massachusetts. It is about 44 miles in length, measured along its course.

The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quantities of coal, iron, clay, moldings, sand, and other heavy articles for its manufactures, depending largely on water transportation, so that vessels of 11 feet draught can reach the city at high water.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

The approved project of 1871, and its subsequent modification, provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to the Ship Yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the Ship Yard down to and through the Needles and Briggs' Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crosses the bottom of the river at Peter's Point, and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton were to be removed.

The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $134,470.44.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the Ship Yard, on account of interfering with private property, and that on account of the hardness and depth of the material at the sides the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge had been completed. The major part of the dredging below the bridge had been done, but this part of the channel still lacked in width at some places. The channel had been cleared of bowlders from Taunton down to Berkley Bridge. The work of uncovering the ledge at Peter's Point preparatory to its removal had been commenced.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $2,917.95 All of the bowlders and gravel overlying the ledge at Peter's Point within the lines of the proposed channel have been removed; the work of blasting the ledge has been completed; the major part of the broken rock has been removed, and the half-tide dam between Reuben's Island and the west shore of the river, constructed with the view of accelerating the current in the dredged channel below, and preventing deposits, has been essentially completed. The ruling depth of water in the river has now been increased from 5 to 11 feet at mean high water, and vessels of 11 feet draught can now reach Taunton, at the head of navigation.

There remains to be done to complete the existing project the completion of the removal of the ledge at Peter's Point; the completion of the dredging of the channel between Berkley Bridge and Dighton, and widening and deepening at a few points above the bridge; all of which it is proposed to finish in the next fiscal year if the funds now available be sufficient, as hoped for.

July 1, 1885, amount available		$22,529 56
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,130 46	
July 1, 1886, outstanding liabilities	787 49	
		2,917 95
July 1, 1886, amount available		19,611 61

(See Appendix C 6.)

7. *Pawtucket River, Rhode Island.*—The navigable part of the Pawtucket (or Seekonk) River, an arm of Providence River, extends from Providence to Pawtucket, a city which has a population of about 23,000 and extensive manufactures depending largely on water transportation. The object of the improvement is to widen and deepen the channel leading to Pawtucket, so that vessels of 12 feet draught can reach that city at mean low water.

Before improvement the channel in the river had a ruling depth of about 5 feet at mean low water.

The original project, as modified in 1883, provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Company's Wharf at Pawtucket; thence, the deepening by blasting of the channel through the ledge to Pawtucket Bridge to the same depth and 40 feet wide.

The amount expended to June 30, 1885, was $52,718.44. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water. A contract had been made for deepening and widening this channel according to the modified plan of 1883, but the work had not been commenced.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $49,241.02. The new channel, 12 feet deep and 100 feet wide, with enlargements at the bends, has been carried from its mouth at the deep water just above Red Bridge, a distance of about 8,740 feet, or to a point about 1,000 feet above a line drawn from Bucklin Island to Swan Point Wharf. A ruling depth of about 6 feet can be carried from the upper end of the present work to Pawtucket.

The work yet to be done is to excavate, by dredging, the channel 12 feet deep and 100 feet wide from the point to which the last contract carried it to a point opposite Grant & Company's Wharf; and from thence to Pawtucket Bridge to deepen the channel through the ledge to the same depth with a width of 40 feet.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the excavation, by dredging, of the upper reaches of the new channel, and, if the funds will admit, to the commencement of the work on the ledge which lies in the channel off Pawtucket.

July 1, 1885, amount available		$49,287 52
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$49,217 27	
July 1, 1886, outstanding liabilities	23 75	
		49,241 02
July 1, 1886, amount available		46 50
Amount appropriated by act approved August 5, 1886		30,000 00
Amount available for fiscal year ending June 30, 1887		30,046 50

Amount (estimated) required for completion of existing project	$302,478 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 7.)

8. *Providence River and Narragansett Bay, Rhode Island.*—Providence River is an estuary of Narragansett Bay. The object of its improvement is to furnish a wide and deep channel for European and coastwise commerce from the ocean to Providence, a city of about 125,000 inhabitants, largely engaged in manufactures, and a port of entry for an extensive region of country with which it is connected by railroads.

Before the improvement of the river was commenced, in 1853, many shoals obstructed navigation, and at one point in the channel, a place called "The Crook," the available low-water depth was but 4½ feet.

There was expended between 1852 and the 30th of June, 1882, $290,459.34 in deepening the channel, first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low water.

The approved project of 1878, modified in 1882, under which the work is now in progress, provides for a channel 25 feet deep and 300 feet wide, suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage-basin between Fox and Field's points of the following dimensions in cross-section, viz: 300 feet wide at a depth of 25 feet, 600 feet wide at a depth of 20 feet, 725 feet wide at a depth of 18 feet, 940 feet wide at a depth of 12 feet, and 1,060 feet wide at a depth of 6 feet.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $210,180.96.

At that date about one-half of the excavation required for the anchorage basin above Field's Point had been done. Bulkhead Rock had been removed, and the condition of the six straight reaches into which the 25-foot channel 300 feet wide is divided, was as follows: The Fox Point, the Sassafras Point, the Field's Point, the Pomham, and the Pawtuxet reaches had been completed, and the lowest, the Gaspee Reach, had been excavated to a width of 200 feet.

For want of funds no work has been in progress during the last fiscal year.

To complete the 25-foot channel 300 feet wide to the deep water of Narragansett Bay there remains the increasing to 300 feet the 200 feet of width already excavated in the lowest (the Gaspee) reach. There also remains for the completion of the existing project the remainder of the excavation of the anchorage basin between Fox and Field's points.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the completion of the dredging required in the Gaspee reach, and to continuing the excavation of the anchorage basin above Field's Point.

July 1, 1885, amount available	$3,419 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	749 93
July 1, 1886, amount available	2,669 74
Amount appropriated by act approved August 5, 1886	30,000 00
Amount available for fiscal year ending June 30, 1887	32,669 74

Amount (estimated) required for completion of existing project	$205,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 8.)

9. *Removal of Green Jacket Shoal, Providence River, Rhode Island.*—This shoal is in that part of the river which constitutes the harbor of Providence. It lies off the wharves on the south front of the city and occupies a part of the harbor that is required for anchorage purposes.

This is a new work, and no appropriation had been made for it until, by act of August 5, 1886, Congress authorized its commencement by making an appropriation of $26,250 therefor.

The report of January 10, 1885, of the survey of this shoal, with plat and estimate of cost of the work ($112,346.25) on which the appropriation was founded, were published in the Annual Report of the Chief of Engineers for 1885, Part I, pages 598–602.

It is proposed with the appropriation of August 5, 1886, to commence the work by removing that part of the shoal where additional anchorage is most required.

Amount appropriated by act approved August 5, 1886 .... $26,250 00

Amount (estimated) required for completion of existing project	86,096 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	28,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 9.)

10. *Warren River, Rhode Island.*—This river is an arm of Narragansett Bay, north of the harbor of Bristol, and, being a new work, no funds had been provided for it until, by act approved August 5, 1886, Congress appropriated $5,000 for its improvement.

The officer in charge, in his report of January 12, 1885, upon the survey, made in accordance with the act of July 5, 1884, stated that the obstructions to navigation were a rocky reef below Little Island, and a submerged bowlder near mid-channel opposite the lower wharf of the town of Warren, and recommended that these obstructions be removed as far as could be done with an expenditure of $5,000 for both purposes. This is doubtless the improvement appropriated for by the act of August 5, 1886, and the funds will be expended accordingly.

Amount appropriated by act approved August 5, 1886 .... $5,000 00

(See Appendix C 10.)

11. *Newport Harbor, Rhode Island.*—This harbor is at the mouth of the main entrance to Narragansett Bay. These waters during summer and winter constitute an important harbor of refuge for our European and coastwise commerce. The objects of the improvement are to widen and deepen the southern (the main) entrance to the harbor, and to enlarge its capacity for vessels seeking refuge in storms by increasing the area and depth of the anchorage within it. Before improvement the capacity of the inner harbor was limited by shoals, and it was not adequate to the number and size of vessels seeking it for refuge. The southern (the main) entrance was obstructed by a bar which stretched out from Goat Island, and the general business wharves of the city could not be reached at low tide by vessels drawing more than 8 feet.

The original project and its modifications, under which work is now carried on, are substantially as follows: Widening and deepening to 15 feet below mean low water the southern (the main) entrance to the

Below Hartford.—Between Hartford and Long Island Sound, a distance of 50 miles by course of channel, the depth on the bars was formerly 5 feet, the worst place being between Hartford and Middletown, a distance of 19 miles, and at Saybrook Bar, at the mouth of the river. Dredging was carried on and small wing-dams constructed by private parties up to 1870, with no permanent benefit. From 1870 to 1880 temporary dredging was done annually by the Government, and jetties on the Saybrook Bar were begun.

In 1880 a project for permanent improvement was adopted, providing for a channel 200 feet wide and 9 feet deep from Hartford to Long Island Sound, to be obtained by rectification and protection of the banks between Hartford and Middletown, by construction of permanent works to confine the current, and by such additions to the Saybrook jetties and such annual dredging as might become necessary, the cost of which could not then be determined; the estimated cost of all but the last two items was $330,000.

The total amount appropriated and expended since the adoption of this project is $135,000.

Two of the permanent works have been built, a training-wall at Hartford Bar and another at Glastonbury Bar, the cost being $37,500; the east and west jetties at Saybrook have been completed, and a channel 120 feet wide and 12 feet deep has been dredged between them; from $5,000 to $10,000 have been annually expended in dredging to maintain 9 feet depth on the bars between Hartford and Middletown.

During the past fiscal year $5,813.51 have been expended in completing the Saybrook jetties and in the necessary annual dredging.

The most important part of the improvement of this river is the dredging of channels through the bars immediately after the spring freshets. For this purpose $13,000 could be profitably expended during the fiscal year ending June 30, 1888, and for repair of the existing wing-walls and of the east jetty at Saybrook, $12,000.

July 1, 1885, amount available	$5,813 51
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	5,813 51
Amount appropriated by act approved August 5, 1886	26,250 00
Amount (estimated) required for completion of existing project	169,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 1.)

2. *Thames River, Connecticut.*—This river is a tidal stream extending from the city of Norwich 15 miles south to Long Island Sound. For 11 miles above its mouth the depth varies from 16 to 80 feet; improvements have been virtually confined to a stretch of 3½ miles below Norwich, in which the most troublesome bars lie. In 1829 the channel depth over these bars was 5 feet at mean low water.

In 1836 a project was approved for making the channel 100 feet wide and 14 feet deep at high water (11 feet at low water) by dredging and by building piers. In 1878 a channel 14 feet deep at low water was projected, and in 1882 a modification was adopted, providing for a channel 200 feet wide and 14 feet deep, to be obtained by dredging and by building 5 dikes or training-walls along the outer curves of the river. The estimated cost was $208,080.

The total amount appropriated for this river is $281,800, of which $75,247.65 have been expended since the adoption of the present project.

Three of the proposed dikes have been completed, and 1,026 linear feet of the fourth one have been built, being about one-quarter of its total length. Dredging was done between the dikes in 1882, 1883, and 1884. Two of the dikes need slight repairs; the channel has about 10 feet available depth.

During the past fiscal year $12,499.95 have been expended in completing the third dike and in building 1,026 linear feet of the fourth.

One hundred thousand dollars could be advantageously expended during a single year in completing the remaining dikes and in dredging.

July 1, 1885, amount available		$17,252 30
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$12,499 95	
July 1, 1886, outstanding liabilities	64 04	
		12,563 99
July 1, 1886, amount available		4,688 31
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		27,188 31

Amount (estimated) required for completion of existing project	105,580 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 2.)

3. *New London Harbor*, *Connecticut.*—This harbor includes the lower three miles of Thames River, from the New London wharves to Long Island Sound.

The project for its improvement, adopted in 1880, and slightly modified in 1882, provides for removing to a depth of 16 feet, at mean low water, the southerly part of a shoal of sand and bowlders lying east of the New London Northern Railroad Wharf. The original depth on this shoal was from 6 to 15 feet.

Seventeen thousand eight hundred dollars have been appropriated for and expended on this work.

The project is about seven-eighths completed, the required depth having been made over nearly the whole area contemplated in the plans.

July 1, 1885, amount available	$160 64
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	160 64
Amount appropriated by act approved August 5, 1886	2,000 00

Amount (estimated) required for completion of existing project	4,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,200 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 3.)

4. *Clinton Harbor*, *Connecticut.*—This harbor lies 10 miles west of the mouth of the Connecticut River. Its channel runs for nearly a mile inside of a beach through which a breach was made about 45 years ago, after which the channel shoaled in two places from 8 to 4 feet.

The project for improvement, adopted in 1882, provided for closing the breach, and if that did not restore the channel, for dredging 100 feet wide, and 6 feet deep, at low water, through the shoals; the entire cost was estimated at $10,000.

Three thousand dollars have been appropriated for this harbor, and $2,747.37 have been expended.

A riprap dike was built across the breach in 1883; it requires some repairs. The channel depth has not changed since 1882.

July 1, 1885, amount available	$306 73
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	54 00
July 1, 1886, amount available	252 73
Amount (estimated) required for completion of existing project	7,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 4.)

5. *New Haven Harbor, Connecticut.*—The original available low-water depth up to the wharves in this harbor was about 9 feet.

The first project for deepening the channel provided for making it 13 feet deep, which was done in 1871; it was widened at different times until 1878, when a project was adopted for dredging a channel 16 feet deep and not less than 400 feet wide. The required depth over the Fort Hale Bar is to be rendered permanent by means of a dike running out from Sandy Point, on the west shore of the harbor, with an arm parallel to the channel; its cost was estimated at $100,000.

Up to the close of the fiscal year $241,000 had been appropriated for this harbor, and nearly all expended.

A 16-foot channel has been obtained from 400 to 600 feet wide, except over the Fort Hale Bar. The shore arm and 254 feet of the channel-arm of the Sandy Point Dike have been built.

During the past fiscal year $9,850.58 have been expended in dredging in the upper part of the harbor to enlarge the water-way under Tomlinson's Bridge, and to widen the channel; the increased width was from 40 to 120 feet, the depth made being 12 feet; its object was to provide a place for vessels waiting to discharge, without obstructing passage through the channel.

The sum of $80,000 is estimated as required to complete the project. This sum could be profitably expended during a single year in completing the Sandy Point Dike, and in dredging.

July 1, 1885, amount available		$10,276 82
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,850 58	
July 1, 1886, outstanding liabilities	290 00	
		10,140 58
July 1, 1886, amount available		136 24
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,136 24
Amount (estimated) required for completion of existing project		80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix D 5.)

6. *Breakwater at New Haven, Connecticut.*—In 1880 a project was adopted for making a large and convenient harbor of refuge at the entrance of New Haven Harbor by the construction of two riprap breakwaters, at an estimated cost of $1,311,134. No modification of this project has been made, except slight changes of cross-section in 1880.

The total amount appropriated for this breakwater is $220,000, of which $218,444.14 have been expended.

The east breakwater has been built 2,147 linear feet, being nearly two-thirds its contemplated length. The west breakwater is not begun.

No work was done on the breakwater during the past fiscal year. Expenditures were made for current office expenses, and for an examination into the condition of the work.

The east breakwater is now far enough advanced to warrant beginning the westerly one, and carrying on both at the same time; $500,000 could be profitably expended on the two breakwaters during the ensuing year.

July 1, 1885, amount available		$3,032 49
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,476 63	
July 1, 1886, outstanding liabilities	140 00	
		1,616 63
July 1, 1886, amount available		1,415 86
Amount appropriated by act approved August 5, 1886		75,000 00
Amount available for fiscal year ending June 30, 1887		76,415 86

Amount (estimated) required for completion of existing project	1,016,134 00
Amount that can be profitably expended in fiscal year ending June 30, 1888.	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 6.)

7. *Milford Harbor*, *Connecticut.*—This harbor consists of a broad, open bay, from the head of which a small tidal stream extends three-quarters of a mile to the village wharves. Originally the depth on the bar at the mouth of the river was 2 feet at mean low water. Above that the channel was nearly bare in places.

Under the first project of improvement, adopted in 1872, a channel 4 feet deep and 100 feet wide was excavated through the bar, and thence 60 feet wide to the village wharves; small jetties were built to protect the east bank from erosion, and two jetties were built to preserve the channel on the bar, at a total cost of $34,600. In 1881 a project was adopted for making a channel over the bar 8 feet deep and 100 feet wide, at an estimated cost of $11,000.

The total sum appropriated for this harbor is $39,600. Of this $4,758.98 have been expended on the last project, and the channel of 8 feet depth has been made 65 feet wide.

No work was done during the past fiscal year.

The officer in charge reports that the project could be satisfactorily completed in one year, at the estimated cost of $6,000.

July 1, 1885, amount available	$269 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	28 27
July 1, 1886, amount available	241 02

Amount (estimated) required for completion of existing project	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 7.)

8. *Housatonic River*, *Connecticut.*—The navigable part of this river extends from Derby, Conn., to Long Island Sound, a distance of 13 miles, and was originally obstructed by several bars upon which the low-water depth was from 3 to 5 feet.

In 1871 a project was adopted for making and maintaining a channel 100 feet wide and 7 feet deep at mean low water throughout this distance; besides the necessary dredging, it contemplated building a breakwater east of the channel over the bar at the river's mouth.

The amount appropriated for this river is $71,200, of which $67,859.18 have been expended.

A channel of the required depth has been dredged several times through the worst bars; the present available depth over them is about 5 feet.

During the past fiscal year a channel 35 feet wide and 7 feet deep was excavated over the bar at the mouth under contract with oyster planters, who wished to use the material, and did the work free of cost to the Government. A similar contract is now in progress for making a channel 9 feet deep and 70 feet wide through the bar. The permanency of this channel, without protection from a jetty, is by no means assured.

During the ensuing year $10,000 could be expended advantageously in building a jetty at the mouth of the river, in removing Drew's Rock, and in maintaining a navigable channel 7 feet deep.

July 1, 1885, amount available	$4,495 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1 155 03
July 1, 1886, amount available	3,340 82
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	8,340 82
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 8.)

9. *Bridgeport Harbor, Connecticut.*—The available depth in this harbor was originally 5 feet at mean low water.

The first project for improvement provided for a jetty on the east shore to check the influx of sand, and for dredging to make a channel 200 feet wide and 12 feet deep at mean low water. In 1882, after the jetty had been built and the desired channel secured, a project was adopted for widening to 600 feet the channel from the inner beacon to the Naugatuck Railroad Wharf, to provide room for vessels driven in by bad weather without blocking the main channel. The estimated cost of the latter project was $60,000.

Two hundred and ten thousand dollars have been appropriated for this harbor, of which $15,000 have been appropriated for, and nearly all expended on, the present project.

The channel has been made 440 feet wide and 12 feet deep between the inner beacon and the railroad wharf. Shoals have been formed in parts of the channel which will require excavating.

No work was done during the past fiscal year.

July 1, 1885, amount available	$792 78
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	619 30
July 1, 1886, amount available	173 48
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	20,173 48
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 river and harbor acts of 1866 and 1867.	

(See Appendix D 9.)

10. *Black Rock Harbor, Connecticut.*—This harbor consists of a bay partly sheltered by Fairweather Island, and of two small tidal streams extending inland from the head of the bay.

The depth in Cedar Creek, the most important of these streams, was from 2 to 4 feet at low water, and the channel was narrow and very crooked.

The project for improvement, submitted in 1883, includes dredging a channel, 3,300 feet long, 80 feet wide, and 6 feet deep to extend up Cedar Creek, and a breakwater 2,700 feet long from Fairweather Island to the mainland; the estimated cost was $80,000.

Twenty thousand dollars have been appropriated and nearly all expended upon this project.

The breakwater has been built the full length, though not to the width and height projected, and the channel has been dredged 35 feet wide, 6 feet deep, and 2,700 feet long.

During the past fiscal year 5,540 tons of stone were delivered in the breakwater, giving it the full length required.

Under the next appropriation dredging will be done as provided by the project; $20,000 could be profitably expended for this work during the next fiscal year.

July 1, 1885, amount available	$9,972 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,168 56
July 1, 1886, amount available	804 20
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,804 20
Amount (estimated) required for completion of existing project	55,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 10.)

11. *Southport Harbor, Connecticut.*—The original depth in this harbor from Long Island Sound to the village wharves was but 2 feet at low water. Between 1829 and 1838 a breakwater and dike were built east of the channel to protect it from drifting sand.

The project for improvement, adopted in 1876 and modified in 1880, included repairing the breakwater and dikes, and dredging a channel 100 feet wide and 4 feet deep to the village wharves.

Thirty-one thousand eighty-seven dollars and twenty-three cents have been appropriated for this harbor, of which $18,000 have been applied to the last project.

The breakwater and dike have been repaired and the channel has been made 4 feet deep with a width of 95 feet outside the end of the breakwater, and 50 to 80 feet wide above that point.

Nothing was done during the past fiscal year.

Although the proposed width of channel has not been fully secured, this improvement may be considered completed as far as is now needed.

No appropriation is required for the ensuing fiscal year.

July 1, 1885, amount available	$159 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	79 47
July 1, 1886, amount available	79 60

(See Appendix D 11.)

distance; besides the necessary dredging, it contemplated building a breakwater east of the channel over the bar at the river's mouth.

The amount appropriated for this river is $71,200, of which $67,859.18 have been expended.

A channel of the required depth has been dredged several times through the worst bars; the present available depth over them is about 5 feet.

During the past fiscal year a channel 35 feet wide and 7 feet deep was excavated over the bar at the mouth under contract with oyster planters, who wished to use the material, and did the work free of cost to the Government. A similar contract is now in progress for making a channel 9 feet deep and 70 feet wide through the bar. The permanency of this channel, without protection from a jetty, is by no means assured.

During the ensuing year $10,000 could be expended advantageously in building a jetty at the mouth of the river, in removing Drew's Rock, and in maintaining a navigable channel 7 feet deep.

July 1, 1885, amount available	$4,495 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,155 03
July 1, 1886, amount available	3,340 82
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	8,340 82
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 8.)

9. *Bridgeport Harbor, Connecticut.*—The available depth in this harbor was originally 5 feet at mean low water.

The first project for improvement provided for a jetty on the east shore to check the influx of sand, and for dredging to make a channel 200 feet wide and 12 feet deep at mean low water. In 1882, after the jetty had been built and the desired channel secured, a project was adopted for widening to 600 feet the channel from the inner beacon to the Naugatuck Railroad Wharf, to provide room for vessels driven in by bad weather without blocking the main channel. The estimated cost of the latter project was $60,000.

Two hundred and ten thousand dollars have been appropriated for this harbor, of which $15,000 have been appropriated for, and nearly all expended on, the present project.

The channel has been made 440 feet wide and 12 feet deep between the inner beacon and the railroad wharf. Shoals have been formed in parts of the channel which will require excavating.

No work was done during the past fiscal year.

July 1, 1885, amount available	$792 78
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	619 30
July 1, 1886, amount available	173 48
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	20,173 48
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 river and harbor acts of 1866 and 1867.	

(See Appendix D 9.)

10. *Black Rock Harbor, Connecticut.*—This harbor consists of a bay partly sheltered by Fairweather Island, and of two small tidal streams extending inland from the head of the bay.

The depth in Cedar Creek, the most important of these streams, was from 2 to 4 feet at low water, and the channel was narrow and very crooked.

The project for improvement, submitted in 1883, includes dredging a channel, 3,300 feet long, 80 feet wide, and 6 feet deep to extend up Cedar Creek, and a breakwater 2,700 feet long from Fairweather Island to the mainland; the estimated cost was $80,000.

Twenty thousand dollars have been appropriated and nearly all expended upon this project.

The breakwater has been built the full length, though not to the width and height projected, and the channel has been dredged 35 feet wide, 6 feet deep, and 2,700 feet long.

During the past fiscal year 5,540 tons of stone were delivered in the breakwater, giving it the full length required.

Under the next appropriation dredging will be done as provided by the project; $20,000 could be profitably expended for this work during the next fiscal year.

July 1, 1885, amount available	$9,972 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,168 56
July 1, 1886, amount available	804 20
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,804 20
Amount (estimated) required for completion of existing project	55,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 10.)

11. *Southport Harbor, Connecticut.*—The original depth in this harbor from Long Island Sound to the village wharves was but 2 feet at low water. Between 1829 and 1838 a breakwater and dike were built east of the channel to protect it from drifting sand.

The project for improvement, adopted in 1876 and modified in 1880, included repairing the breakwater and dikes, and dredging a channel 100 feet wide and 4 feet deep to the village wharves.

Thirty-one thousand eighty-seven dollars and twenty-three cents have been appropriated for this harbor, of which $18,000 have been applied to the last project.

The breakwater and dike have been repaired and the channel has been made 4 feet deep with a width of 95 feet outside the end of the breakwater, and 50 to 80 feet wide above that point.

Nothing was done during the past fiscal year.

Although the proposed width of channel has not been fully secured, this improvement may be considered completed as far as is now needed.

No appropriation is required for the ensuing fiscal year.

July 1, 1885, amount available	$159 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	79 47
July 1, 1886, amount available	79 60

(See Appendix D 11.)

The project for improvement, adopted in 1872 and modified in 1873, provided for a channel 9 feet deep at high water, extending to a point 3,000 feet above Lockwood's, and for 5,800 feet of diking to maintain the channel. The estimated cost was $136,500.

Of this sum $54,000 have been appropriated and nearly all expended.

The channel has been made 9 feet deep and 125 feet wide to the head of Goose Island, one-half mile from the mouth of the creek; thence to Town Dock from 40 to 90 feet wide, and from Town Dock to Lockwood's 100 feet wide, and 1,235 linear feet of diking have been built.

No work was done during the past fiscal year.

July 1, 1885, amount available	$81 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	32 60
July 1, 1886, amount available	48 90
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,048 90

Amount (estimated) required for completion of existing project	72,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1857.	

(See Appendix D 20.)

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR.

Officer in charge, Lieut. Col. Walter McFarland, Corps of Engineers, with Lieut. George McC. Derby, Corps of Engineers, under his immediate orders.

1. *Hudson River, New York.*—The improvement of the channel of this river has been chiefly confined to a stretch of about 21 miles, extending from Troy, at the head of navigation 6 miles above Albany, down to New Baltimore, about 14 miles below Albany.

Before the present scheme of improvement was adopted in 1867, a depth of 7.5 feet could be carried at low water from New Baltimore to Albany, and 7.2 feet from Albany to Troy. According to the survey made in September, October, and November, 1884, 10 feet could then be carried from New Baltimore to Albany, except at one point, Beacon Island, where there was a depth of but 8.8 feet at mean low water, and 8 feet could be carried from Albany to Troy, except at Covill's Folly and Patroon's Island, where the depths were 7.8 and 7.5 feet, respectively, at low water.

The channels over several of these shoals have since been deepened by the dredges employed by the State.

The project for the improvement of the river adopted in 1867, provided for securing, by means of longitudinal dikes and by dredging, channels of 11 feet deep at mean low water, between New Baltimore and Albany, and 9 feet deep between Albany and Troy.

The original estimate of cost was increased by the addition of new work in 1868, and again in 1882, when the total cost of executing the project was estimated at $1,062,304; of this amount the sum of $1,053,538, has been appropriated, including $26,250 appropriated by the act of

The project for improvement, adopted in 1871 and modified in 1875 and 1877, provided for making an entrance channel 100 feet wide and 8 feet deep at mean low water, by dredging through the bar and protecting the cut by two jetties. The estimated cost of this work was $79,000, which has all been appropriated.

The channel has been dredged to the width and depth provided; the east jetty has been made 1,390 feet long, and the west jetty 940 feet; at the time of completion they extended, respectively, to 10 and 6½ feet depth.

No operations were carried on during the past fiscal year.

This improvement is completed for the present; it may become necessary to extend the project in order to maintain the channel permanently.

No appropriation is needed for the ensuing year.

July 1, 1885, amount available	$475 06
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	90 70
July 1, 1886, amount available	384 36

(See Appendix D 18.)

19. *Flushing Bay, New York.*—Before improvement the available depth in this broad shallow bay and in the channel leading to Flushing was less than 4 feet at mean low water.

The project for improvement, adopted in 1879, contemplated building 16,700 feet of diking, to form a tidal basin, which, by filling and discharging through the main channel, would maintain a channel depth of 6 feet or more at mean low water, after once dredging; the material of the bottom is soft mud. The estimated cost of this work was $173,500.

Nearly all of the appropriations for this harbor, amounting to $60,000, have been expended.

The dike on the west side of the channel has been built 3,057 feet long, and the channels through the bay and up the east and west branches of Flushing Creek have been dredged 6 feet deep; the former twice.

No operations were carried on during the past fiscal year, except placing beacons to mark the dike at high tide.

Thirty-five thousand dollars could be profitably expended during the ensuing fiscal year in extending the dike and in maintaining the channel depth.

July 1, 1885, amount available	$699 02
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	326 55
July 1, 1886, amount available	372 47
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,372 47
Amount (estimated) required for completion of existing project	103,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 19.)

20. *East Chester Creek, New York.*—This is a small tidal stream emptying into Pelham Bay; it was navigable at high tide to vessels drawing 7 feet, up to Lockwood's, a distance of 2¼ miles. The rise of tide is 7.1 feet.

Amount (estimated) required for completion of existing project	$17,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 15.)

16. *Mamaroneck Harbor, New York.*—This harbor consists of a narrow inlet opening into a broad bay. Several dangerous rocks lay in or near the channel. The low-water depth to the Old Steamboat Wharf, about half way up the inlet, was 5 feet; from there to the upper wharves it was about 1 foot.

A project for improvement was adopted in 1882, providing for the removal of one rock to 4 feet depth, of five rocks to 7 feet depth, and for making a channel 100 feet wide and 7 feet deep up to the Old Steamboat Wharf, thence to the village wharves 80 feet wide and 4 feet deep; the estimated cost was $43,000.

Fifteen thousand dollars have been appropriated for this harbor and nearly all expended.

Three of the rocks have been removed to the required depth; no dredging has been done.

July 1, 1885, amount available	$301 23
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	77 00
July, 1, 1886, amount available	224 23

Amount (estimated) required for completion of existing project	28,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 16.)

17. *Greenport Harbor, New York.*—This harbor, at the eastern end of Long Island, is exposed to easterly storms; its anchorage ground, which was sheltered by Joshua's Point, has materially shoaled by erosion of the point and by the influx of drifting sand.

The project of improvement, adopted in 1882, provided for construction of a riprap breakwater, extending from Joshua's Point 1,700 feet in a southeasterly course, to arrest drifting sand, to check the erosion of the point, and to increase the sheltered area; its cost was estimated at $46,000.

Twenty thousand dollars have been appropriated for this harbor, and nearly all expended.

The breakwater has been built out to the 10-foot curve, a distance of 1,233 feet.

July 1, 1885, amount available	$300 78
July 1, 1886, amount available	300 78
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,300 78

Amount (estimated) required for completion of existing project	21,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 17.)

18. *Port Jefferson Harbor, New York.*—This harbor is a large, deep bay, with a narrow entrance at the outer side, of which the channel depth was but 3 feet at mean low water.

Congress, approved August 5, 1886, which would leave $8,766 still to be appropriated. But of this amount over $35,000 have been already expended on the repair of the existing works, and the last two appropriations of July 5, 1884, and August 5, 1886, amounting to $56,250 must be applied in the same way to repairs and not to construction.

Of the works included in the original estimate, six yet remain to be constructed or completed.

These were estimated to cost in 1832	$78,000
To which must be added the removal of a rock near Van Wie's Point in the Overslaugh Channel, not included in the original estimate, estimated at	16,000
Total	94,000

Since 1882 little or nothing has been done towards their completion, the funds having been chiefly spent in repairs, so that this amount, $94,000, is still required for the completion of the scheme of improvement.

The act of August 5, 1886, reads:

> Improving Hudson River, New York: Continuing improvement, $26,250; of which which $15,000 may be used for the removal of the rock in channel at Van Wie's Point.

Considering the satisfactory results hitherto obtained, the material assistance afforded by the State of New York every year, and the large commerce of the river, the present funds made available for this improvement, by act of Congress approved August 5, 1886, will be applied to the repair of existing works, and a further sum of $94,000 should be appropriated for the completion of the original project.

July 1, 1885, amount available	$31,570 74
Received from sales of fuel	39 36
	31,610 10
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,091 70
July 1, 1886, amount available	28,518 40
Amount appropriated by act approved August 5, 1886	26,250 00
Amount available for fiscal year ending June 30, 1887	54,768 40
Amount (estimated) required for completion of existing project	94,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,750 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 1.)

2. *Harbor at Saugerties, New York.*—To comply with the river and harbor act of August 2, 1882, two projects for the improvement of the mouth of this harbor, so as to give an 8-foot channel, by means of parallel dikes and dredging, were submitted November 28, 1883. For one plan the estimated cost was $46,419.80. For a second plan the estimated cost was $43,113.50.

In view of the fact that the State of New York had undertaken to make some improvement here it was decided not to begin work, but to wait until further examination could be made.

No work has been done by the United States Government during the year, but the State of New York has dredged a channel 8 feet deep and about 200 feet wide from the 8-foot curve in the Hudson River to the 8-foot curve inside the mouth of the Esopus Creek.

With the balance of the old appropriation and the $15,000 appropriated by act of Congress approved August 5, 1886, it is proposed to begin the diking.

July 1, 1885, amount available	$4,955 95
July 1, 1886, amount available	4,955 95
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	19,955 95
Amount (estimated) required for completion of existing project	26,419 80
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 2.)

3. *Harbor at Rondout, New York.*—The original condition of the navigable channel of this harbor showed a depth of about 7 feet at mean low water.

A project adopted in 1872 provided for the construction of two parallel dikes running from the mouth of the creek into the Hudson River, and a longitudinal dike on the river side, connecting with the north dike in the creek, to direct the current of the Hudson River, and to protect the dikes from running ice, and finally for such dredging in the channel as would secure a depth of 13 feet at mean low water.

The original estimate for this work was $172,000, subsequently modified to $104,000, of which $94,000 have been appropriated.

The project has virtually been completed; there being a 13-foot channel between the dikes.

No work has been done during the fiscal year. The $2,500 appropriated by act approved August 5, 1886, will be applied to widening the outlet between the dikes and making the necessary repairs to them.

The estimated cost of completing the project and giving the outlet the full width originally proposed is $10,000, of which $2,500 has been appropriated.

July 1, 1885, amount available	$60 36
July 1, 1886, amount available	60 36
Amount appropriated by act approved August 5, 1886	2,500 00
Amount available for fiscal year ending June 30, 1887	2,560 36
Amount (estimated) required for completion of existing project	7,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 3.)

4. *Harlem River, New York.*—The survey of this work was directed by an act of Congress approved June 23, 1874, and was made in the fall of that year under the direction of General Newton. The preliminary report upon it was made February 18, 1875, and a final report was given in General Newton's annual report for 1884. It provides for securing a channel from the Hudson River through Spuyten Duyvel Creek and the Harlem River to the East River 15 feet deep at low water and 400 feet wide, except in the cut which is to be made through Dyckman's Meadow, where the width, for the sake of economy, is to be reduced to 350 feet.

The estimated cost of this work is $2,700,000, of which $400,000 have been already appropriated, but with the condition attached that no part of it is to be expended until the right of way for the improvement is secured without cost to the United States.

Under an act of the legislature of the State of New York all expenses incurred in securing the right of way and in paying for land damages are to be assessed upon the property bordering on the line of the proposed improvement.

The report of the commissioners appointed by the supreme court of the State of New York to secure the right of way free of cost to the United States is still awaiting the action of the court, as stated in the last annual report.

July 1, 1885, amount available	$400,000 00
July 1, 1886, amount available	400,000 00
Amount (estimated) required for completion of existing project	2,300,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix E 4.)

5. *Removing obstructions in East River and Hell Gate, New York.*—General John Newton, Chief of Engineers, retained the charge of these works, with Lieut. Col. Walter McFarland, Corps of Engineers, on duty in connection with them, and Lieut. George McC. Derby, Corps of Engineers, in superintendence of the operations at Flood Rock, and of the steam-drilling scow until December 31, 1885, when the works were put in charge of Lieut. Col. Walter McFarland, Corps of Engineers.

In its original condition the channel of East River and Hell Gate was obstructed by many large and dangerous reefs, some of which projected above high water, others having least depths on them varying from nothing to 17½ feet at mean low tide. Owing to the violence of the currents, the sudden change at right angles in the direction of the river, and the crowded condition of this thoroughfare, vessels were continually being wrecked on these reefs.

The first project for the improvement of Hell Gate was adopted in 1867, and was subsequently modified in 1868, 1874, 1880, and 1884, by extending it to embrace the removal of other reefs in Hell Gate and in the East River. It now includes the removal to a depth of 26 feet at mean low water of all the dangerous reefs in Hell Gate, Diamond Reef, and North Brother Island Reef in the East River; the removal of Coenties Reef, East River, to 25½ feet, the removal of a number of small rocks in the shoaler portions of the channels; and the construction of sea-walls on Great and Little Mill rocks, and on Hog's Back and Holmes Rock.

The original estimate for this project was $5,139,120. The amount expended to the end of the fiscal year is $3,467,331.80, with which about four-fifths of the project have been completed, greatly to the relief of navigation.

During the fiscal year the great mine at Flood Rock has been fired, and the whole of the Middle Reef broken with entire success. About $100,000, saved from the estimated cost of the blast, has been expended in dredging, resulting in the production of a through channel 320 feet wide and 18 feet deep at mean low water across the most dangerous portion of the reef.

The appropriation of $500,000 asked for is to be applied to continuing the removal of the débris of Flood Rock by contract and to operating the United States steam-drill scow on Heel Tap and Frying Pan.

July 1, 1885, amount available		$267,949 74
Received from sales of fuel		29 25
		267,978 99
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$197,502 30	
July 1, 1886, outstanding liabilities	29,828 35	
		227,330 65
July 1, 1886, amount available		40,648 34
Amount appropriated by act approved August 5, 1886		112,500 00
Amount available for fiscal year ending June 30, 1887		153,148 34
Amount (estimated) required for completion of existing project		1,488,840 67
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E 5.)

6. *Newtown Creek, New York.*—This is a tidal stream about 4 miles long, running through the eastern part of Brooklyn, and emptying into the East River opposite Thirty-fourth street, New York City.

It had originally a depth of but 12½ feet at low water from its mouth up to Vernon Avenue Bridge, a distance of 1,100 feet, its width for this distance being about 240 feet; thence it gradually decreased in depth and width until, at the head of navigation, where Metropolitan avenue crosses it, there was a low-water depth of about 4 feet and a width of about 100 feet.

In 1880 it was decided to dredge a channel about 200 feet wide and from 18 to 21 feet deep at low water from the mouth of the creek up to Vernon Avenue Bridge, the estimated cost of which was $44,050.

In 1884 a survey was made and a project adopted for carrying the improvement from the Vernon Avenue Bridge to the head of navigation, a distance of about 4 miles, with a depth of 18 feet and a width of 175 feet from Vernon Avenue Bridge to the Central Oil Works; thence to Queens County Oil Works 15 feet deep and from 120 to 150 feet in width; thence to the Nichols Chemical Works 12 feet deep and from 125 to 150 feet wide; and thence to the head of navigation in both branches, namely, the points where they are crossed by the Metropolitan Avenue Bridge, 10 feet deep and from 100 to 125 feet wide.

The estimated cost of this improvement was $211,519, making the total estimated cost of the projected improvement of Newtown Creek $255,569, of which $45,000 have been appropriated up to June 30, 1886.

The only parts of the creek at which work has been done so far are at the mouth, where a channel 18 feet deep and from 75 to 150 feet wide has been excavated, extending from the East River up to Vernon Avenue Bridge, a distance of a little over 1,000 feet; and also near the head of the creek, where channels 10 feet deep and from 50 to 200 feet wide have been dredged from Covert's Dock up to the head of navigation at Grand street, on the west branch, a distance of about 3,000 feet, and from Covert's Dock up the east branch to the Grand Street Bridge.

No work has been done during the past fiscal year.

The act of Congress approved August 5, 1886, appropriating $37,500 for continuing the improvement directs "$9,375 to be expended on west branch between Maspeth avenue and Dual Bridge, at Grand street and Metropolitan avenue; $9,375 to be expended on main branch between Easterly Grand Street Bridge to Metropolitan avenue; and balance on lower end, from Maspeth avenue to the mouth of the creek."

This appropriation will be applied to dredging channels at the points indicated, which are at the upper end of the creek, and in the lower portion of the creek; to widening the channel at Penny Bridge, and below the Vernon Avenue Bridge.

As the creek has no fall and as it is the receptacle for all the refuse from the factories, refineries, and slaughter-houses of the east of Brooklyn, constant deposits are forming in it, which will necessitate annual dredging, even after the project has been completed, and as the banks are of marsh mud they will continue to wash into the channel until they are protected by bulkheads the whole way up from the mouth.

The commerce of the creek is so large that the improvement should be pushed at least 3 miles up as rapidly as possible, and, in the opinion of the officer in charge, $100,000 can be well applied there in the next fiscal year.

July 1, 1885, amount available	$7,419 96
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,110 43
July 1, 1886, amount available	6,309 53
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	43,809 53
Amount (estimated) required for completion of existing project	173,069 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 6.)

7. *Buttermilk Channel, New York.*— This channel lies between the city of Brooklyn, N. Y., and Governor's Island, New York Harbor, and is obstructed at its upper end, where it joins the East River, by a shoal over which there is a minimum depth of 9½ feet at mean low water. The crest of this shoal lies about 800 feet outside the line of the Brooklyn wharves.

The original project of improvement, adopted in 1881, provides for the removal to a depth of 26 feet at mean low water of such parts of the shoal as came within 850 feet of the Brooklyn wharves, which would take off the crest of the shoal and give nowhere less than 15 feet water on it.

The estimated cost of this improvement was $210,000, of which $190,000 has been appropriated up to June 30, 1886.

With this the channel has been widened to the full width proposed, and deepened to not less than 24 and probably 26 feet at mean low water. But as no survey has been made since the last work done, it cannot be definitely stated whether the full depth of 26 feet was obtained by the last dredging.

The importance of this part of the East River to the commerce of the harbor is so great that it is proposed to remove the whole shoal to a depth of 26 feet.

The crest of the shoal has unquestionably a less depth of water upon it than it had a few years ago, on account, principally, it is supposed, of the ashes spilled from an ash scow which was anchored there to receive the ashes from tug-boats and small steamers.

The estimated cost of removing the remainder of the shoal to a depth of 26 feet mean low water is $170,000 according to the latest data.

In view of the importance of the improvement and the very large commerce in this part of New York Harbor, it is recommended that $50,000 be granted to carry on the improvement.

The appropriation of $56,250, by act approved August 5, 1886, will be applied to widening the channel already dredged.

July 1, 1885, amount available	$324 97
July 1, 1886, amount available	324 97
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	56,574 97
Amount (estimated) required for completion of existing project	113,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts 1866 and 1867.	

(See Appendix E 7.)

8. *Gowanus Bay, New York.*—The depth of water in the channels of Gowanus Creek and Bay was originally only from 7 to 12 feet at mean low water, which was wholly insufficient for the passage of vessels employed in the commerce of the district.

The plan of improvement, adopted in 1881, provided for giving a depth of 18 feet to the channels in the bay leading up to the mouth of the creek on both the north and south sides, and for carrying the improvement with the same depth up the creek to Hamilton Avenue Bridge, a distance of about 1 mile. The channel widths were to be 200 feet except for the last few hundred feet up to the bridge, where the width would gradually decrease.

The estimated cost of this improvement was $192,564.90, of which $65,000 had been appropriated up to June 30, 1886. With this money the northern channel leading up the creek has been completed and the dredging has been carried on up the creek to within 2,100 feet of Hamilton Avenue Bridge; and the southern channel has been dredged to within 2,000 feet of the mouth of the creek.

The act approved August 5, 1886, appropriated $7,500, which will be expended in continuing the improvement.

The commerce using the channels in Gowanus Bay and Creek is very large, and $50,000 is recommended by the officer in charge for continuing the improvement.

July 1, 1885, amount available	$167 74
July 1, 1886, amount available	167 74
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,667 74
Amount (estimated) required for completion of existing project	120,064 90
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 8.)

9. *Gedney's Channel, New York.*—The act of Congress approved July 5, 1884, appropriated $200,000 for deepening Gedney's Channel through "Sandy Hook Bar, New York."

No previous survey with a view to the improvement of this channel, or of the interior channels of the lower bay of New York, had been ordered by Congress, or had been made under direction of the War Department. Consequently, on the 5th of August, 1884, upon recommendation of the Chief of Engineers, and Board of Engineers for Fortifications and for River and Harbor Improvements, the Secretary of War ordered a survey to be made of the entrance to New York Harbor, between Long Island and Sandy Hook, extending eastward to the 12-fathom curve outside the bar, and westward to the west side of the main ship-channel leading down from the Narrows to the point of Sandy Hook.

This survey was made under direction of Maj. G. L. Gillespie, Corps of Engineers, in the autumn of 1884, and his report with maps was submitted December 6, 1884.

That report stated that the low-water depth on the bar was between 23 and 24 feet; that the large steamers making use of the harbor drew, loaded, from 26 to 28 feet; and that the low-water depth on the bar should be greater than this, in order to permit the passage of these vessels at all stages of the tide. That such an increased depth could only be maintained, probably, by the construction of permanent works in the nature of dikes; but that as the act of Congress making the appropriation distinctly designated that it should be applied to deepening Gedney's Channel, the engineer in charge recommended that it should be applied to dredging Gedney's Channel between the 30-foot curves inside and outside of it, although there was a part of the channel, near Flynn's Knoll, that was just as much in need of deepening; and that in any event the experiment of keeping this channel open by dredging ought to be tried before considering the question of constructing permanent works for the same purpose.

That report was referred to the Board of Engineers for Fortifications and for River and Harbor Improvements, whose opinions in the matter were summed up as follows:

> The Board recommends, as a general plan for improving the entrance to New York Harbor so as to give 30 feet from New York to the ocean, the construction of a low-water or half-tide stone dike, running about south southeast from Coney Island to such distance as shall be found necessary, and probably not less than 4 miles, the protection of the head of Sandy Hook, and the dredging of a 30-foot channel from deep water near Sandy Hook to deep water below the Narrows; also the immediate dredging of a channel 1,000 feet wide and 28 feet deep through the shoal west of Flynn's Knoll, as soon as Congress shall furnish the funds; also that the existing appropriation be applied to dredging Gedney's Channel to a depth of 28 feet.

In regard to the expenditure of the $200,000 appropriated July 5, 1884, while the Board did not expect large results from dredging, they recommended that the experiment should be made; but that if it was found that the channels rapidly filled up during the dredging the work should be suspended.

Proposals were therefore asked for deepening the channel by one of the different methods of dredging, and these were opened January 15, 1885, when a contract for dredging by means of a hydraulic plow or water-jet was let to Roy Stone, with a provision that if, after fair trial, his method should be found impracticable, the work could be stopped without his receiving any pay from the Government. His method proved to be a failure, and he was released from the contract at his own request. No payment was made to him by the Government, as no results had been obtained.

Proposals were therefore again invited, and opened June 23, 1885, and a contract was awarded to Elijah Brainard July 21, 1885, at 54 cents per cubi cyard.

The contractor proposed to put on a hydraulic pumping plant capable of excavating 3,000 cubic yards of solid material per day. The plant was built, and work was begun September 26, 1885, but the capacity of the plant did not come up to the expectations of the builder or the requirements of the contract; and during the spring of 1886 the contractor built a second and larger plant; and also in May, 1886, hired a third plant.

Up to the close of the fiscal year, 86,708 cubic yards of material had been excavated.

Owing to difficulties in conducting the work, the contract was extended from June 30, 1886, to November 1, 1886.

The average daily capacity of the three plants, on working days, irrespective of breakdowns, may be put at 3,400 cubic yards for a working day of 15 hours.

On June 30, the channel had an increased depth of 1.5 feet for a width of 400 feet on the north side, giving nearly 25 feet of water, where in places a little over 23 had existed before.

This seemed to prove, up to June 30, at least, that it was possible to deepen the channel by the method in use. But whether the channel so dredged may be regarded as permanent, or even partly so, cannot be determined until after the effects of the coming winter storms are observed.

If no material shoaling takes place on this bar during the winter, it seems probable that the required depth may be preserved by annual dredging, and it may be unnecessary to undertake the construction of permanent works, but it is impossible to say yet whether it will be a success or not.

The river and harbor act approved August 5, 1886, appropriated $750,000 for "improving New York Harbor, New York: To secure a thirty-foot channel at mean low water at Sandy Hook entrance of the harbor, upon such a plan as the Secretary of War may approve."

It is probable that the larger part of this amount will be applied to the dredging in both the outer and inner channels, as recommended by the Board of Engineers in the extract from their report before given.

July 1, 1885, amount available		$186,469 35
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$27,281 86	
July 1, 1886, outstanding liabilities	27,115 37	
		54,397 23
July 1, 1886, amount available		132,072 12
Amount appropriated by act approved August 5, 1886		750,000 00
Amount available for fiscal year ending June 30, 1887		882,072 12
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		6,000,000 00

(See Appendix E 9.)

10. *Sheepshead Bay, New York.*—The project for this improvement, adopted in 1879, provided for the maintenance of the natural outlet of the bay into Rockaway Inlet, by means of diking and dredging, and for the contraction of the channel in the bay above by means of dikes, so as to afford a channel 6 feet deep up to the head of navigation about 2 miles above the mouth.

The depth of water at the mouth was about 2 feet, but the channel was uncertain and shifting. The rise and fall of tide was stated to be 4.5 feet.

The estimated cost of the improvement was $100,000.

A resurvey was made in 1882, when the old outlet was found to be nearly closed up, and it was proposed to cut a new outlet 6 feet deep and 100 feet wide north of the old one, into Dead Horse Inlet, and to dredge the interior channels of the bay to a depth of 6 feet at mean low water.

The estimated cost of this was $34,200, of which $16,000 had been appropriated up to June 30, 1886.

After some correspondence and delay the new outlet was excavated, protected on the north side by a bulkhead built partly by the property-owners and partly by the contractor who was doing the dredging for the Government.

The navigation of the bay is restricted almost entirely to pleasure boats used by the Coney Island and Gravesend Bay hotels, and there seems to be no present necessity for further appropriation for this improvement.

The appropriation of $5,000, approved August 5, 1886, will be applied to dredging shoals in the cut and in closing up the old inlet which has reopened during the last winter.

July 1, 1885, amount available	$4,967 83
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,684 10
July 1, 1886, amount available	283 73
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,283 73
Amount (estimated) required for completion of existing project	13,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 10.)

11. *Canarsie Bay, New York.*—The project for this improvement, adopted in 1879, was to obtain a channel, by means of diking and dredging, from the 6-foot curve in Jamaica Bay up to the Canarsie Dock, a distance of about 3,500 feet. The proposed channel was to be 6 feet deep at mean low water, the mean range of tides being 4.7 feet.

The estimated cost of this improvement was $88,000, of which $23,000 had been appropriated up to the fiscal year ending June 30, 1886. With this amount a pile dike 1,050 feet long was built on the north side of the outer end of the channel, and a channel 6 feet deep and from 50 to 75 feet wide was dredged from the 6-foot curve in Jamaica Bay up to the dock of Canarsie Landing. Narrow cuts were also made along two faces of the dock.

No work has been done during the fiscal year, but serious shoaling has occurred at the upper and lower ends of the dike, and as the set of the ebb current is directly across the line of the dike and dredged channel, it is evident that no permanent benefit will occur until the south channel dike is built.

Canarsie Landing, apart from having a large trade in oysters, clams, and fish, is the terminus of the Brooklyn, Rockaway and Jamaica Bay Railroad, from which point people transship to Rockaway Beach. Two steamers make six trips a day in summer from Canarsie to Rockaway, besides one steamer running throughout the year to Barren Island.

It is believed the construction of the south dike and a little more dredging would give the necessary facilities to commerce.

July 1, 1885, amount available	$486 74
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	287 63
July 1, 1886, amount available	199 11
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,199 11

Amount (estimated) required for completion of existing project	55,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 11.)

12. *Sumpawanus Inlet, New York.*—The original project, adopted in 1880, provides for dredging a channel about 4,500 feet long, 100 to 150 feet wide, and 5 feet deep at the mean low water from the 5-foot curve in Great South Bay, up to the town of Babylon, Long Island.

The navigable depth at the time of the survey, made with a view to this improvement, varied from 5 feet at mean low water in the bay to 2 feet at the wharf, and thence from 1 to 2 feet at mean low water up the creek a distance of a little over half a mile.

The range of tides was approximately 1.3 feet.

Owing to the peculiarities of the locality there was no scour in the channel, nor could it be obtained by contracting the channel width, and every indication was that, of late years, not only the channel, so called, but that part of the Great South Bay near it has been filling in gradually but steadily.

The scheme proposed, therefore, was to give a 5-foot channel 100 feet wide by dredging from the deeper waters of the bay up to the mouth of the creek, a distance of 1,500 feet, and thence up the creek for a distance of 3,500 feet, the estimated cost being $23,115.

Seven thousand dollars were appropriated for the improvement in 1881 and 1882, and with that a channel was dredged up to the mouth of the creek not less than 75 feet wide from a point 750 feet southeast of the dock at the mouth of the creek, and cuts 25 feet wide were made round the sides of the dock.

No work has been done since May 17, 1883.

Owing to the high price of dredging and small appropriations, the original estimate of cost was increased to $40,000.

The commerce has changed materially since the original survey, and most of the trade is now done by rail, except the summer trade, which is carried in three steamboats of light draught over to Fire Island, and in pleasure-boats of very light draught taking boating and fishing parties out into Great South Bay.

Any further appropriations for this work should be applied to giving a good channel 5 feet deep from the deeper waters of Great South Bay up to the mouth of the creek; but apart from the steamboat interest the commerce is too small to warrant a continuation of the improvement.

July 1, 1885, amount available	$106 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	25 05
July 1, 1886, amount available	81 88

Amount (estimated) required for completion of existing project	33,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 12.)

13. *Manasquan River, New Jersey.*—The present project was adopted in 1879, and provided for opening a direct outlet 6 feet deep and 250 feet wide into the Atlantic Ocean through the beach and the sand-bars lying outside of it, by means of parallel jetties at the mouth of the river.

The depth of water on the bar at the mouth, which formerly lay 400 feet north of the proposed mouth, was from 1 to 1½ feet, and varied and shifted continually. The project also contemplated the dredging of an inner basin 2,000 feet by 200 feet and 5 feet deep at low water. The estimated cost of executing this scheme was $72,000.

The alleged object of the improvement was to furnish to small coasters a harbor of refuge midway between Sandy Hook and Barnegat Inlet; but it was stated by the Board of Engineers, to whom the project was submitted, that the desired harbor could not be obtained and maintained except at a cost so large as to be unwarranted by any possible prospective commerce.

There was practically no existing commerce. However, appropriations were made, amounting, up to August 2, 1882, to $72,000, and by the 30th of June, 1883, two parallel jetties had been built across the beach at right angles to the shore-line. The north jetty 1,513 feet in length; the south jetty 475 feet, and a channel had been dredged between them.

No appropriations have been made to protect the existing work since August 2, 1882, and no work has been done since June 30, 1883.

At first, this change in the mouth served its purpose so well that a depth of from 3 to 4 feet was secured across the outside bar and through the new channel between the jetties and was maintained for several years; but the beach kept making round the outer end of the jetties, and it was soon evident that the channel would be shortly closed, unless the jetties were extended out to the 1 or 2 fathom curve outside. A large shoal at the inner end of the north jetty also began to make over towards the inner end of the south jetty, and drove the current across to that side of the river so as to threaten making a breach through the beach back of it.

The present condition of the improvement is most unsatisfactory.

The shoal above mentioned has increased until the low-water mark is about 20 feet outside of the inner end of the south jetty, and the inner 150 feet of the jetty is now directly in midchannel.

The filling of this 150 feet of the jetty has been completely washed out, the beach has made up to the outer end of the north jetty, and past the outer end of the south jetty, and outside, and about 200 feet distant from the ends of the jetties a shoal has formed, awash at low water, with channels north and south of it, with from 1 to 1½ feet of water in them at mean low water.

The outlet now is in worse condition than before the improvement was begun. There is not now, nor has there ever been, any commerce in Manasquan. The little there is is done by railroad.

The Manasquan River is only used by pleasure-boats, drawing from 6 inches to 2 inches, hardly any of which go outside.

There appears to be no good reason for continuing this improvement, and no money is, therefore, asked for it.

Amount (estimated) required for completion of existing project.......	$33,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 13.)

14. *Shrewsbury River, New Jersey.*—The Shrewsbury River, emptying into Sandy Hook Bay, New Jersey, is formed by the union of two branches which meet at Rocky Point, just below Seabright, 3 miles above the river's mouth. One branch, called the North Shrewsbury River, is navigable to Red Bank, about 4 miles above the junction; for the upper 3 miles of its course it widens out into a large, shallow, landlocked bay. The other branch, called the South Shrewsbury River, is

navigable to Branchport, about 5 miles above the junction; and for the upper 3 miles of its course broadens out into a similar shallow bay, known as Pleasure Bay.

Both these bays have channels through them 6 feet deep at mean low water; but the lower mile of the North Branch and the lower 2 miles of the South Branch, as well as the main river below their junction, have always been obstructed by bars which proved serious obstacles to their navigation.

In 1870 a project for improving their navigation by dredging was formed, the estimated cost of the work being $14,000. This amount was appropriated, and subsequently a further sum of $5,000, all of which was applied to the work between 1871 and 1874. But the improvement did not prove permanent, and in 1878 a second survey was ordered, on which the present project of improvement is based. This provided for obtaining a channel 6 feet deep at mean low water, by diking and dredging from the mouth of the main river up into both branches.

This project was referred for consideration to a Board of Engineers, who, after making certain modifications in the plans, estimated the cost of the improvement at $142,086.

From June 18, 1878, to August 2, 1882, inclusive, $174,000 was appropriated for the improvement, but nothing since that time up to June 30, 1886.

With these appropriations a dike, 4,021 feet long, was built at the mouth of the river, and channels were dredged up to the junction of the two branches 6 feet deep and from 25 to 100 feet wide, as needed. From the junction at Rocky Point a dike was built on the right bank of the North Branch, extending up-stream towards Barley Point, 1,885 feet long, and from Barley Point a dike 598 feet long was built, extending down-stream towards the other dike, leaving a space between their extremities of 1,940 feet.

On the South Branch a dike 1,856 feet long was built on the left bank of the river, connecting with the lower end of the dike built on the North Branch; and at the entrance to Pleasure Bay a dike 1,513 feet long was built on the left bank from Gunning Island down-stream, and a dike 503 feet long was built opposite to it on the right bank. Channels 6 feet deep were also dredged where needed, from 75 to 100 feet in width on the North Branch, and from 60 to 150 feet in width on the South Branch, including some rock excavation in the channel above Seabright Bridge on the South Branch.

These channels have since shoaled in some places and have deepened in others, so that now a scant 5 feet can be carried through the North Shrewsbury, a scant 4½ feet through the South Shrewsbury, and 5 feet over the bar at the mouth.

The cost has already exceeded the estimate, partly on account of the increased cost of dredging and diking, and partly on account of having to re-dredge in places. But the commerce of the river appears to warrant the maintenance of a 6-foot channel at low water, and $40,000 is recommended, by the officer in charge, for continuing the improvement, exclusive of the $10,000 appropriated by act approved August 5, 1886.

July 1, 1885, amount available	$577 20
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	355 50
July 1, 1886, amount available	221 70
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,221 70

Amount (estimated) required for completion of existing project	$40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 14.)

15. *Harbor at Keyport, New Jersey.*—The project for this improvement, approved in 1872, was to dredge a channel 8 feet in depth, at mean low water, and 200 feet wide from the steamboat wharf at Keyport to the 8-foot curve in Raritan Bay, a distance of about 5,000 feet, at a cost of $30,475.

No money for this purpose was furnished until August 2, 1882, when the whole amount was appropriated, and in 1882–'83 a channel was dredged from the steamboat wharf at Keyport to the 8-foot curve in the bay, 8 feet deep and 200 feet wide, except for a short stretch between the steamboat wharf and the wharf of the New York and Freehold Railroad, where it was only 160 feet wide.

No appropriations have been made since.

In 1884 an appropriation of $10,000 was recommended to complete the improvement.

The commerce of Keyport is stated to have increased from $3,000,000 in 1872 to $5,650,000 in 1884, and it is recommended that the improvement be completed.

July 1, 1885, amount available	$982 19
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	30 20
July 1, 1886, amount available	951 99

Amount (estimated) required for completion of existing project	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 15.)

16. *Mattawan Creek, New Jersey.*—Mattawan Creek empties into Raritan Bay at Keyport, New Jersey. The project for its improvement, adopted in 1881, provided for a channel 4 feet deep at mean low water and 100 feet wide from the mouth for about 1½ miles up and thence 75 feet wide to the head of navigation at the Long Branch Railroad crossing, 2 miles above the mouth, at a cost of $33,120.

The original depth was 2 feet at mean low water and the range of tides 4.7 feet.

The appropriations up to and including that of August 2, 1882, amounted to $21,000. With this a channel 100 feet wide and 4 feet deep had been dredged up to Winkson's Dock,— feet above the mouth; thence to a point 600 feet above the brick-yards, 4 feet deep and 50 feet wide; thence to the railroad bridge, a distance of 2,000 feet, 30 feet wide, and 4 feet deep; and a basin was dredged opposite the steamboat dock at the head of navigation, so as to enable the steamboat to turn.

No appropriation has been made since that of August 2, 1882, and no work done since 1883.

Under the original estimate $12,120 is required to complete the improvement; but by a subsequent estimate made in 1884 it was estimated that the project could be completed for $9,000.

The amount of commerce of the creek is stated to be valued at $150,000, consisting of $70,000 worth of bricks and $80,000 worth of sundries.

The existing commerce does not seem to warrant further appropriations at present.

Amount (estimated) required for completion of existing project........	$12,120 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 16.)

17. *Cheesequakes Creek, New Jersey.*—The original project, adopted in 1879, provided for a new outlet 5 feet deep from the creek into Raritan Bay, at right angles to the shore line, through a beach which put across the mouth of the creek from the right bank, and which had forced the outlet nearly half a mile to the westward. This was to be obtained by dredging and constructing parallel jetties each side of the dredged channel; the old outlet was to be closed by a pile dike, and a channel 4 feet deep and from 50 to 100 feet wide was to be dredged from the mouth to the head of navigation, 3½ miles up the creek. In this distance two dikes were to be built, and a new channel to be made through the marsh, was to cut off a bend in the creek.

The available navigable depth in the creek was originally 1½ feet at mean low water over the shoals.

The rise and fall of tide was 5.1 feet.

The estimated cost of the improvement was $75,279.

The total appropriations up to June 30, 1886, have been $40,000, and with this amount the old outlet has been closed, and the proposed new channel through the beach dredged out into Raritan Bay 5 feet deep, with dikes built on each side.

The channel has shoaled about half a foot since the dredging was done.

No work has been done above the mouth of the creek, but it is believed that the improvement made so far is all that is warranted by the present commerce, and no further appropriation is asked for.

July 1, 1885, amount available..	$1 52
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1 52

Amount (estimated) required for completion of existing project........	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 17.)

18. *Raritan Bay, New Jersey.*—The present project, adopted in 1880, provides for opening a channel, by dredging, 8,000 feet long, 300 feet wide, and 21 feet deep, at mean low water, through a shoal on the north side of Raritan Bay, east of Seguines Point, so as to permit the passage of deep-draught vessels to or out from the Amboys and Raritan River. The original depth upon the shoal was 14½ feet. The estimated cost of the improvement was $126,500, of which, up to June 30, 1886, $120,000 had been appropriated, and the channel was completed for the proposed length, depth, and width in 1884. A survey made in 1885 showed that the side slopes of the cut had run in, so as to give a channel-width of only 250 feet, with a depth of 21 feet.

In 1884 it was recommended that an interior channel, leading from Great Beds Light up to Perth Amboy, by Ward's Point, on the Staten Island shore, should be dredged 300 feet wide and 21 feet deep, and in 1885 it was recommended that a 15-foot channel, 300 feet wide, should be dredged from outside of Great Beds Light up to South Amboy.

The estimated cost of the excavation of these two channels and for widening the channel east of Seguines Point to 300 feet was $114,000.

The channel east of Seguines Point appears to be sufficient for the existing commerce at present, and the $37,500 appropriated August 5, 1886, will be applied to the interior channels after a survey has been made.

The shipments of coal, iron ore, and other heavy freights from the Amboys, which pass through this channel, is very large, and is carried in sea-going vessels and steamers drawing 20½ feet and under, and the existing project, as modified in 1884 and 1885, should be carried out.

July 1, 1885, amount available	$724 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	31 95
July 1, 1886, amount available	692 75
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	38,192 75
Amount (estimated) required for completion of existing project	76,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 18.)

19. *Raritan River, New Jersey.*—The project for the improvement of this river, adopted in 1874, provided for a channel 10 feet deep and 200 feet wide from the mouth up to New Brunswick, a distance of 12½ miles, by means of diking and dredging, at a cost of $2,093,662.05.

New Brunswick is at the head of navigation, although the river is navigable by boats of light draught 5 miles further up. The Delaware and Raritan Canal opens into the river at New Brunswick and has a depth of 8 feet.

When the improvement was begun in 1874 the river was obstructed by two long shoals, beginning about 5 miles above the mouth, known as the Stakes and the Middle Ground, with from 6 to 7 feet water on them; the river at this point is half a mile wide, and it was proposed to contract this width to about 800 feet by means of dikes, and to dredge a channel along them.

For 4 miles below New Brunswick the river was very much narrower, and was crossed by rock, gravel, and bowlder bars, with from 7 to 8 feet of water upon them.

A slight addition to the original project was made in 1881, providing for a channel 100 feet wide and 5½ feet deep at low water inside the dikes on the southern side of the river at the Stakes and Middle Ground; the estimated cost of which was about $50,000, the object being to accommodate the factories on the right bank of the river which were cut off from the main channel by the dikes.

Up to June 30, 1886, $445,000 had been appropriated for the improvement, and the following work had been done:

The dikes at the Stakes and Middle Ground have been completed, and there is a channel over those shoals 11½ feet deep at mean low water, and varying from 130 to 200 feet in width; 4,000 linear feet of the projected 13,000 feet of the South Channel has been completed.

On this part of the river, therefore, the following work remains to be done under the project: to widen the channel at the Stakes from 130 to 200 feet, and to excavate the remainder of the South Channel for a distance of 9,000 feet. No work has been done on this part of the river during the fiscal year ending June 30, 1886.

On the upper 4 miles of the river the only important work that has been done is the excavation of a rock-reef known as "Rocky Reach," 4 miles below New Brunswick; this work has been nearly completed, as a channel 200 feet wide and 12 feet deep has been excavated through the shoal, except for a distance of 150 feet at the lower end, where the width is only 180 feet. The only work done on this part of the river during the fiscal year ending June 30, 1886, was the excavation of 6,392 cubic yards of material from Rocky Reach with the small balance of the appropriation of July 5, 1884, which was available at the beginning of the fiscal year.

The work remaining to be done, therefore, on this part of the river is the excavation of a 10-foot channel from above Rocky Reach to New Brunswick, a distance of about 3½ miles, and the finishing of the little remaining work in Rocky Reach.

Under the appropriation of $26,250 approved August 5, 1886, it is proposed to extend the improvement up-stream from Rocky Reach by dredging and blasting towards New Brunswick.

The commerce of the Raritan River is very large and thoroughly warrants the early completion of the project.

One hundred thousand dollars is recommended to be appropriated for the fiscal year ending June 30, 1888, for continuing the improvement.

July 1, 1885, amount available	$10,727 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	10,109 43
July 1, 1886, amount available	617 98
Amount appropriated by act approved August 5, 1886	26,250 00
Amount available for fiscal year ending June 30, 1887	26,867 98
Amount (estimated) required for completion of existing project	1,622,412 05
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 19.)

20. *South River, New Jersey.*—This river is a tributary of the Raritan River, entering it from the southward about 8½ miles above its mouth.

In order to cut off a great bend, a canal was dug by the New Jersey Transportation Company about fifty years ago from a point on South River to the Raritan, 1¼ miles below the natural mouth, thereby saving a distance of over 3 miles.

The first Government survey with a view to its improvement was made in 1870, and $20,000 was appropriated and expended in 1872-'73 in deepening the canal.

No work was then done until 1879, when the present project was adopted, which was to form a channel 150 feet wide and 8 feet deep by means of diking and dredging from the lower end of the canal up to the village of Little Washington, a distance of about 1½ miles, and thence by the same means up to Old Bridge, 4½ miles further, by channels 100 and 60 feet wide and 6 and 4 feet deep, respectively. The project also provided for closing up the old channel about 2½ miles above its mouth.

The estimated cost of the project was $194,695, of which $56,000 had been appropriated up to June 30, 1886. With this, dikes have been built on each side of the canal for about half its length up from its mouth, and a long training-dike has been built on the south (right) bank between the head of the canal and Little Washington. With the exception of cutting a short channel through a shoal just above Little Washington, no work has been done above the village.

The dikes appear to have done good service so far, but it will be necessary to protect the banks of the canal through its entire length, as they are undermining and falling in, so that shoals are forming rapidly.

No work has been done during the fiscal year.

Under the appropriation of August 5, 1886, it is proposed to extend the dikes in the canal up-stream.

For so small a stream the commerce is large, and indicates that the river is worthy of improvement under the present project.

July 1, 1885, amount available	$382 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	21 36
July 1, 1886, amount available	361 27
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,361 27
Amount (estimated) required for completion of existing project	133,695 00
Amount that can be profitably expended in fiscal year ending June 30, 1888.	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 20.)

21. *Woodbridge Creek, New Jersey.*—The project for this improvement adopted in 1878, provided for dredging a channel 80 feet wide and 12 feet deep at *mean high water* from the mouth of the creek up to the town dock, a distance of about 2 miles, over which a depth of from 7½ to 12 feet at *mean high water* had originally existed.

The estimated cost of this improvement was $13,809.14; $19,000 had been appropriated to June 30, 1886, for this improvement, which has been virtually completed, and the channel appears to be ample for the existing commerce. No appropriation is therefore asked for.

The exceedingly high prices of dredging increased the cost of the work 50 per cent. more than the original estimate.

The commerce of the creek consists in shipments of brick, tiles, and fire-clay from seven factories, situated on the creek from the mouth to the town dock, and from the numerous beds of fine clays and fire-clay which are situated near its banks. The commerce of the creek is estimated at about 120,000 tons yearly, carried in vessels of from 6 to 10 feet draught.

Amount (estimated) required for completion of existing project	$10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 21.)

22. *Rahway River, New Jersey.*—The project for improvement of this river, adopted in 1878, provided for dredging a channel from Bricktown, nearly 4 miles above the mouth, up to the Main Street Bridge, in the town of Rahway, a distance of 6,900 feet. The channel proposed was to be 125 feet wide and 8 feet deep at *mean high water* from Bricktown to the Milton Avenue Bridge in Rahway, a distance of 5,500 feet, and thence only 100 feet wide and 8 feet deep at *mean high water* up to the head of navigation at the Main Street Bridge, a distance of 1,400 feet.

The range of tides is 5.3 feet.

The estimated cost of this work, including the removal of a large bowlder at Bricktown, was $36,653. Up to and including the act of August 2, 1882, $37,000 had been appropriated for this improvement, with which an improved channel not less than 7 feet in depth at *mean high water* has been obtained to within 550 feet of the head of navigation at the Main Street Bridge.

No appropriation has been made since that of August 2, 1882.

Owing to the great difference between the originally estimated and the actual price of dredging, it was estimated in 1882 that to carry out the project would increase the estimated cost $37,500, but it is also stated in the report for 1883, as well as in subsequent reports, that the existing channel is sufficient for the present needs of commerce, which has fallen from an estimated amount of 120,500 tons in 1879 to 48,500 tons in 1884 and 1885.

The channel may be regarded as sufficient for the present requirements of the commerce, and no further appropriation is now asked for.

July 1, 1885, amount available	$200 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	21 10
July 1, 1886, amount available	179 60
Amount (estimated) required for completion of existing project	29,250 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 22.)

23. *Elizabeth River, New Jersey.*—The project for this improvement, adopted in 1879, provided for dredging a channel 7 feet deep at *mean high water*, and 60 feet wide, from the mouth of the river up to the Stone Bridge at Broad street, in the city of Elizabeth, a distance of 2¾ miles.

Before this improvement was begun, there was a depth at *mean high water* of 8½ feet at the mouth, and 3 feet at the Stone Bridge, while the depth for nearly a mile below the bridge was only from 3 feet to 3½ feet.

The mean rise and fall of the tides is stated to be 4.7 feet at the mouth and 3.4 feet at the Stone Bridge.

The estimated cost of this improvement was $25,530; but, on account of the excessively high prices bid for the dredging in carrying out the work, this estimate was increased in 1881 to $43,160.

Twenty-seven thousand dollars have been appropriated for the improvement up to June 30, 1886, with which a channel 7 feet deep at *mean high water*, and from 50 to 60 feet wide, has been dredged from the mouth nearly up to the Stone Bridge.

It has been stated in previous reports that this is all that is required for the existing commerce, and no furthor appropriation is asked for at present.

July 1, 1885, amount available	$601 64
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	20 80
July 1, 1886, amount available	580 84
Amount (estimated) required for completion of existing project	16,160 00
Submitted in compliance with the requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 23.)

24. *Channel between Staten Island and New Jersey.*—The improvement of this channel has, so far, been restricted to that part of Staten Island

Sound, about 1¾ miles long, which lies between Elizabethport, N. J., and Newark Bay.

The project for its improvement, first proposed in 1873 and since modified, provides for dredging a channel east from Elizabethport to the deep waters of the Kill von Kull 400 feet wide and 13 feet deep at mean low water. At first it was meant to make only the middle part of this channel 13 feet deep, the outside part being but 12 feet deep.

Previous to the beginning of this work 9½ feet had existed over this shoal at mean low water.

The estimated cost of dredging this channel to the full depth of 13 feet was $150,000. In addition to this, it was decided, should it be found necessary, to build four dikes along the line of the channel, two on the north side and two on the south, the estimated cost of which was $60,000, making the total cost of the proposed improvement $210,000.

Up to June 30, 1886, $154,000 have been appropriated for this work. With this amount the channel has been given the full width and depth proposed, and in 1874–'75 2,237 linear feet of dike were built on the south side of the channel, under the first project.

It is not thought advisable at present to begin either of the four dikes proposed in the modified project of 1880, and it is proposed to maintain the channel by dredging and to widen certain parts so as to enable vessels to pass each other more easily.

The $15,000 appropriated by act of Congress approved August 5, 1886, will be applied to dredging, and a further sum of $30,000 is asked for continuing the improvement.

July 1, 1885, amount available	$397 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	397 47
Amount appropriated by act approved August 5, 1886	15,000 00
Amount (estimated) required for completion of existing project	91,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 24.)

25. *Passaic River, New Jersey.*—The Passaic is a large river in New Jersey, emptying into Newark Bay. It is navigable to Passaic, about 13 miles above its mouth. Four miles above the mouth is situated the city of Newark, N. J.

The appropriation for this river has been divided into two parts:

1. The Passaic River above Newark, from the Pennsylvania Railroad Bridge, in the city of Newark, to the head of navigation at Passaic.

2. The Passaic River below Newark, from the Pennsylvania Railroad Bridge down to the mouth.

1. The Passaic River, above Newark: The original navigable depth of this part of the river was about 2½ feet at mean low water, the rise and fall of tides being nearly 5 feet at Newark and 3 feet at Passaic.

The channel was obstructed by rocky and gravelly bars, notably those called Middle Bar, Lime Kiln, Belleville, Rutherford Park, and Holsman's.

The project for its improvement, adopted in 1872, provided for obtaining, by means of diking and dredging, a channel 6 feet deep and from 60 to 70 feet wide from Newark up to Passaic, the estimated cost of which was $123,924.

Up to June 30, 1886, $124,000 had been appropriated; and a channel not less than 6 feet in depth and from 60 to 125 feet wide had been obtained from the Pennsylvania Railroad Bridge in Newark to Passaic, the head of navigation.

The dredged channels have slightly deteriorated at different times, but the project may be called completed.

The $2,250 allotted by act of August 5, 1886, for this part of the river will be applied to removing any obstructions which may form in the river from ice or freshets next spring.

The commerce of this part of the river is quite large.

July 1, 1885, amount available	$2,272 26
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,034 30
July 1, 1886, amount available	237 96
Amount appropriated by act approved August 5, 1886	2,250 00
Amount available for fiscal year ending June 30, 1887	2,487 96
Amount (estimated) required for completion of existing project	7,512 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

2. The Passaic River below Newark: The project for this part of the river, adopted in 1880, provided for obtaining a 10-foot channel at mean low water, 200 feet wide, from the Pennsylvania Railroad Bridge in Newark to Newark Bay, by means of diking and dredging, the estimated cost being $232,875.

In 1884 this project was modified so as to include the deepening of the channel through certain shoals in Newark Bay by dredging and by extending the dike at the mouth of the river about 8,000 feet into the bay, as it was found that these shoals had less water over them than the improved channel in the river.

The estimated cost of this modification was $121,000, making a total estimate for the whole project of $353,875. Of this, $148,000 had been appropriated up to June 30, 1886, and a channel through the bay and up the river to the Newark and New York Railroad Bridge has been excavated 12 feet deep and 200 feet wide. From the Newark and New York Railroad Bridge up to the Pennsylvania Railroad Bridge a channel varying in width from 100 to 200 feet, and 12 feet deep, has been dredged, and 4,705 linear feet of diking has been built at the mouth of the river.

To complete the improvement 7,300 linear feet of diking will have to be built in Newark Bay and the channel dredged to full width above the Newark and New York Railroad Bridge.

With the appropriation of $24,000 made by act of Congress of August 5, 1886, for this part of the river, it is proposed to extend the diking into the bay a distance of 1,000 linear feet.

The commerce of the river up to Newark is estimated at 1,200,000 tons yearly, besides which the commerce of the Hackensack uses the channel in Newark Bay.

The commerce warrants the completion of the project as soon as possible; $125,000 is asked by the officer in charge for the fiscal year ending June 30, 1886, to continue the improvement.

July 1, 1885, amount available	$6,711 12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,138 30
July 1, 1886, amount available	572 82
Amount appropriated by act approved August 5, 1886	24,000 00
Amount available for fiscal year ending June 30, 1887	24,572 82

Amount (estimated) required for completion of existing project	$181,875 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	60,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 25.)

IMPROVEMENT OF DELAWARE AND SCHUYLKILL RIVERS AND OF RIVERS IN NEW JERSEY—HARBOR IMPROVEMENTS IN DELAWARE RIVER AND BAY—CONSTRUCTION OF PIER AT LEWES—DELAWARE BREAKWATER.

Officer in charge, Lieut. Col. Henry M. Robert, Corps of Engineers.

1. *Delaware River from Trenton, New Jersey, to its mouth.*—Trenton is the head of natural navigation on the Delaware River. Between Trenton and the upper part of Philadelphia, a distance of about 30 miles, the river in its orginal condition was obstructed by shoals which reduced the depth at low water to 3 or 4 feet in the upper part, and to 6 or 7 feet in the lower part of this distance of 30 miles.

Below Philadelphia the river in its original condition presented obstructions at Mifflin Bar which reduced the depth at mean low water to 17 feet, at Schooner Ledge and Cherry Island Flats to 18 feet, at Bulkhead Shoals and Dan Baker Shoals to about 20 feet.

The project for the comprehensive improvement of the Delaware River between Trenton and the upper part of Philadelphia has not yet been considered. Efforts in the past have been directed toward relieving commerce from the obstructions which exist in the upper 8 or 10 miles of the river, or that part between Kinkora Bar and Trenton. This part of the river was originally obstructed with shoals which reduced the available depth at low water to from 3 to 4 feet. By dredging, a depth of from 6 to 7 feet has been obtained in this upper 10 miles of river, except at Periwig Shoal, which is about 2½ miles below Trenton, where there is at present a depth of only 3 feet at low water. A detailed survey of the river between Bridesburg and Trenton is in progress for the purpose of obtaining the necessary data for determining upon a comprehensive plan for the permanent improvement of the river between Trenton and the upper part of Philadelphia to meet the requirements of commerce, and also the plan adopted for the improvement of the river at and below Philadelphia.

The efforts of the past to improve the river between Philadelphia and the bay have been confined to dredging, except at Schooner Ledge, where solid rock has been removed, under appropriations for special localities and also under general appropriations for the Delaware River below Bridesburg.

A Board of Engineers, convened by direction of the Secretary of War for the purpose of considering the subject of the permanent improvement of Delaware River and Bay, recommended, under date of January 23, 1885, the formation of a ship-channel from a point opposite Philadelphia and about midway between the American Shipbuilding Company's yard and the Gas Trust Wharf to deep water in Delaware Bay, having a least width of 600 feet, and a depth of 26 feet at mean low water. The formation of such a channel is to be obtained, except at Schooner Ledge, where rock would require to be removed, by regulating the tidal flow by means of dikes, with recourse to dredging where necessary as an aid to such contracting and regulating works. The estimated cost of obtaining a channel of the above dimensions is about $2,425,000, which covers the estimated cost of the permanent improvement of the Delaware River between the upper part of Philadelphia and deep water in the bay. The entire cost of the permanent improvement of the river between Trenton, N. J., and its mouth cannot be stated until after the completion of the survey between Bridesburg and Trenton and the formation of a project based thereon.

The entire amount expended on the improvements of the Delaware River from 1836 to June 30, 1885, under appropriations both for the general river and for special localities, was $1,364,746.87, of which $45,000 was expended on that part of the river between Trenton and the upper part of Philadelphia. At the latter date, there had been formed a channel of navigable width and 7 feet deep at mean low water through the bars between Bridesburg and Bordentown; 200 feet wide and 9 feet deep at mean low water over the bar between Bridesburg and the head of Petty's Island Bar; 225 feet wide and 24 feet deep through Petty's Island Bar; 300 feet wide and 10 feet deep at mean low water through Smith's Island Bar; 300 feet wide and 26 feet deep at mean low water through Mifflin Bar; 330 feet wide and 24 feet deep at mean low water through Schooner Ledge; 470 feet wide and 24 feet deep through Cherry Island Flats; and 385 feet wide and 24 feet deep at low water through Bulkhead Shoals.

During the fiscal year ending June 30, 1886, the sum of $134,971.05 was expended in surveys, examinations, and tidal observations; in dredging through Five Mile Bar just above Petty's Island, in the main ship-channel west of Petty's Island, and at Mifflin Bar; and in dike construction near Periwig Shoals above Bordentown, between Fisher's Point and the upper end of Petty's Island, and between Hog and Maiden islands near Mifflin Bar.

The dredging through Five Mile Bar is still in progress, and has resulted, so far, in opening a channel between the deep water above and below the bar about 100 feet wide and 10 feet deep at mean low water. The dredging west of Petty's Island has widened the main channel to a width of about 400 feet, with a depth of from 24 to 26 feet at mean low water. The dredging at Mifflin Bar was applied to the deepening of the previously dredged channel to a depth of 26 feet at mean low water. The dikes are as yet unfinished and the extent of their action towards deepening adjacent channels undetermined.

An appropriation of $500,000 is recommended for the fiscal year ending June 30, 1888, which would be applied in accordance with the approved project.

July 1, 1885, amount available		$185,555 96
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$133,273 88	
July 1, 1886, outstanding liabilities	34,374 09	
		167,647 97
July 1, 1886, amount available		17,907 99
Amount appropriated by act approved August 5, 1886		210,000 00
Amount available for fiscal year ending June 30, 1887		227,907 99
Amount (estimated) required for completion of existing project		*2,215,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix F 1.)

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* This amount of $2,215,000 covers the estimated cost of the permanent improvement of the Delaware River between the upper part of Philadelphia and deep water in the bay. The entire cost of the permanent improvement of the river between Trenton, N. J., and its mouth cannot be stated until after the completion of the survey now in progress between Bridesburg and Trenton and the formation of a project based thereon.

2. *Delaware River at Schooner Ledge.*—This locality is about 19 miles below Philadelphia. In its original condition the obstruction to navigation consisted of a ledge of rock, with superposed gravel and bowlders, lying in the main ship-channel quite close to the Delaware shore. The depth of water over this ledge was about 18 feet and the obstruction was dangerous to navigation.

The original project for its improvement was to obtain a channel 24 feet deep at mean low water by the removal of rock and other material, at an estimated cost of $227,000. Under the general project of the Board of Engineers of 1884 the improvement of this part of the river was included in the comprehensive plan for the permanent improvement of Delaware River and bay so as to obtain a depth of 26 feet at mean low water, with a least channel-width of 600 feet at all points where a less depth and width now exist below Philadelphia.

Work under the original project was commenced in 1879, and continued to 1884, when the available funds became practically exhausted. The amount expended to June 30, 1885, was $169,837.07, and had resulted in the formation of a channel through the ledge 330 feet wide and 24 feet deep at mean low water.

Specific appropriations are not recommended for this work. The improvement of this locality is considered in the report of the Board of Engineers of 1884, and forms a part of the comprehensive plan for the permanent improvement of the Delaware River as recommended by the Board.

July 1, 1885, amount available	$162 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	162 93
Amount (estimated) required for completion of existing project	(*)

(See Appendix F 2.)

3. *Delaware River near Cherry Island Flats.*—This locality is about 28 miles below Philadelphia. In its original condition the obstruction to navigation consisted of a shoal about 2 miles in length between the 24-foot curves, carrying a least depth of about 18 feet at mean low water.

The original project for its improvement was to obtain by dredging a channel of navigable width and 24 feet deep at mean low water, at an estimated cost of $522,720. Under the general project of the Board of Engineers of 1884 the improvement of this part of the river was included in the comprehensive plan for the permanent improvement of Delaware River and bay, so as to obtain a depth of 26 feet at mean low water, with a least channel-width of 600 feet, at all points where a less depth and width now exist below Philadelphia.

Work under the original project was commenced in 1879 and continued through 1883, when the available funds became practically exhausted.

The amount expended to June 30, 1885, was $398,543.26, and had resulted in the formation of a dredged channel through the shoal about 470 feet wide and 24 feet deep at mean low water.

Specific appropriations are not recommended for this work. The improvement of this locality is considered in the report of the Board of Engineers of 1884, and forms a part of the comprehensive plan for the permanent improvement of the Delaware River, as recommended by the Board.

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[*] Included in amount required for completion of existing project, "Delaware River from Trenton, N. J., to its mouth."

July 1, 1885, amount available	$1,456 74
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,456 74
Amount (estimated) required for completion of existing project	(*)

(See Appendix F 3.)

4. *Frankford Creek, Pennsylvania.*—This creek flows eastward to the Delaware River, through the northern portion of the city of Philadelphia. The grounds of the Frankford Arsenal border upon the left bank of the creek. In its original condition it had a low-water width of about 100 feet, and a low-water depth of about 5 feet at its mouth, above which it rapidly shoaled for a distance of about 3 miles, to the head of tidal flow.

The original project proposed the formation of a dredged channel 50 feet wide from its mouth to Frankford avenue, a distance of about 3 miles, the channel to have a depth of 3 feet at mean low water at its upper end, and increasing to 7 feet at its mouth. The estimated cost was $40,000.

The act of August 2, 1882, appropriated $10,000, which was applied to the formation of a dredged channel 7 feet deep from its mouth to Horseshoe Bend.

This creek, being entirely within the corporate limits of Philadelphia, is being regulated by the city, and no further appropriation for its improvement by the United States is recommended.

No work has been done since 1883. The amount expended to June 30, 1885, was $9,442.83.

July 1, 1885, amount available	$557 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	292 67
July 1, 1886, amount available	264 50
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	30,000 00

(See Appendix F 4.)

5. *Schuylkill River, Pennsylvania.*—When the work of improvement was commenced in 1870 there was a channel of entrance into the mouth of the river carrying a depth of only 15 feet at mean low water.

The original project under which work was commenced in 1870 proposed the formation of a channel 100 feet wide with a depth of 20 feet from the mouth of the river to Gibson's Point, and a depth of 18 feet from thence to Chestnut Street Bridge in Philadelphia.

In 1875 and 1883 this project was amended so as to increase the mean low-water channel between the mouth and Girard Point to 400 feet wide and 24 feet deep, and from Girard Point to Gibson's Point to 250 feet wide and 20 feet deep.

The amount expended upon these projects to June 30, 1885, was $331,701.23, and has resulted in the formation of a channel as follows: From the mouth to Girard Point piers, a distance of about 1 mile, the channel was 300 feet wide and 24 feet deep at mean low water; from Girard Point to Gibson's Point, a distance of about 3 miles, the channel was 150 to 200 feet wide and 20 feet deep; from Gibson's Point to Chestnut Street Bridge, a distance of about 3 miles, the channel was 150 feet wide and 18 feet deep at mean low water. This latter reach of river has required no other improvement than the removal of about 1,000 cubic yards of rock near Locust and South streets.

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* Included in amount required for completion of existing project, "Delaware River from Trenton, N. J., to its mouth."

During the fiscal year ending June 30, 1886, the sum of $17,914.15 was expended in widening and deepening the channel at points between Gibson's and Girard points by the removal of about 36,000 cubic yards of material.

The sum of $75,000 can be profitably expended during the fiscal year ending June 30, 1888, in continuing the dredging of the channel. The commerce of the river is rapidly increasing, and the improvement of the river to the completion of the existing project would be of great advantage.

July 1, 1885, amount available	$11,578 97
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,194 35
July 1, 1886, amount available	384 62
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	19,134 62
Amount (estimated) required for completion of existing project	116,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	58,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867	

(See Appendix F 5.)

6. *Ice-harbor at Marcus Hook, Pennsylvania.*—This work in its present plan was commenced in 1867, the object being to provide a harbor to protect vessels against moving ice.

The original project with the amendments thereto proposed the construction of stone piers behind which vessels could anchor, and the construction of a bulkhead about 1,800 feet in length, parallel to the shore line, and about 150 feet outside of high-water line, together with the deepening by dredging of the area behind the piers and in front of the bulkhead.

The amount expended from 1866 to June 30, 1885, was $171,561.84, and resulted in the construction of three landing-piers and seven detached ice-piers, and the deepening by dredging to a depth of 18 feet of a part of the area between the first and second pair of piers. Extensive repairs were also made to the piers from time to time.

The work done rendered the harbor available for a limited number of vessels of comparatively light draught seeking protection against running ice.

During the fiscal year ending June 30, 1886, $7,438.16 was expended in deepening, by dredging to a depth of 22 feet at mean low water, the area between the first and second pairs of ice-piers, and to a depth of 24 feet the area between the second and third pairs of ice-piers. A group of mooring piles was also placed midway between the inner lines of the first and second and the second and third pairs of ice-piers. This work renders about two-thirds of the harbor available at mean low water for vessels drawing from 22 to 26 feet, and gives also increased mooring facilities.

The amount required for the completion of the existing project could be profitably expended during the fiscal year ending June 30, 1888, in giving increased harbor facilities, by the construction of the bulkhead, and dredging.

July 1, 1885, amount available	$7,438 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	7,438 16
Amount appropriated by act approved August 5, 1886	15,000 00
Amount (estimated) required for completion of existing project	35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 6.)

7. *Ice-harbor at head of Delaware Bay, Delaware.*—The act of August 2, 1882, appropriated $25,000 for the commencement of work on the ice-harbor at the head of Delaware Bay, to include the removal of some sunken piers, the remains of an old ice-harbor, in the channel east of Reedy Island, Delaware.

The necessity for an ice-harbor at the head of Delaware Bay has long been recognized, and considerable study has been devoted to the questions of location and general plan of construction. As to location, the prevailing judgment would place the ice-harbor at or very near Liston's Point. The plan of construction which has been hitherto proposed in general terms provided for a nearly inclosed area, by means of a barrier, to protect vessels against moving ice. This barrier was to consist of iron piles placed at intervals and connected with an iron superstructure so arranged as to either hold or ward the ice from the area within the barrier. The cost of such an ice-harbor has been variously estimated at from $300,000 to $400,000.

In the opinion of the officer in charge the plan of detached ice-breakers, as heretofore used in all the ice-harbors on the Delaware River, is preferable to that of an inclosed area, which latter would prevent the broken ice from escaping from the harbor; but as to whether these ice-breakers should consist of stone piers, or pile piers, or floating pontons requires more time for decision.

The problem of successfully designing and constructing an ice-harbor at the head of Delaware Bay is difficult, and of a character where precedent furnishes but small guidance; therefore, before the work is commenced the most careful examination and study should be given to the question.

The amount expended to June 30, 1885, was $7,500, of which $3,700 was applied to the removal of the sunken piers back of Reedy Island, as provided in the act of August 2, 1882, making the appropriation of $25,000. The balance of $3,800 was expended in surveys, examinations, and preliminary studies.

During the fiscal year ending June 30, 1886, nothing was expended.

No appropriation is recommended at present by the officer in charge.

July 1, 1885, amount available	$17,500 00
July 1, 1886, amount available	17,500 00
Amount (estimated) required for completion of existing project	381,090 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 7.)

8. *Construction of iron pier in Delaware Bay, near Lewes, Delaware.*—The original project for this work proposed the construction of a landing-pier about 1,700 feet in length, extending from the shore south of the breakwater into Delaware Bay to a depth of 22 feet at mean low-water, the pier to consist of a substructure of wrought-iron screw-piles sur-

mounted with a timber superstructure. The work was commenced in 1871 and completed, except as to superstructure, in 1880.

The amount expended to June 30, 1885, was $367,612.72, and resulted in the construction of 1,155 linear feet of pier 21 feet in width, and 546 linear feet 42 feet in width, or a total length of 1,701 feet. The depth of water at the outer end of the pier-head was about 21 feet at mean low water.

From the decayed condition of the timber superstructure it was not available for use by the railroad, to which the right was given to use the pier under the provisions of the act of July 15, 1870.

During the fiscal year ending June 30, 1886, $700.14 was expended in the care of the work and its property.

If the pier is to be rendered available for the general purposes of the Government, and also for railroad traffic, as contemplated in the act above referred to, the officer in charge recommends the replacing of the present decayed wooden superstructure by permanent iron-work at an estimated cost of $93,000. If this is approved by Congress the entire amount could be profitably expended during the fiscal year ending June 30, 1888, as when the change in superstructure commences the pier is useless until the change is completed.

July 1, 1885, amount available	$887 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	700 14
July 1, 1886, amount available	187 14
Amount (estimated) required for completion of existing project	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 8.)

9. *Delaware Breakwater Harbor, Delaware.*—Under act of Congress, May 7, 1822, $22,700 was appropriated for a survey of Delaware Bay, near Cape Henlopen, for the purpose of determining upon the site for a harbor of shelter. In 1828 an appropriation of $250,000 was made for commencing the work, under a plan submitted by a Board of Commissioners appointed by Congress.

The project of the Board contemplated the construction in the concavity of the bay, just inside Cape Henlopen, of two massive works on the *pierres perdues* or riprap system, separated by an interval or gap of 1,390 feet—the greater, called the breakwater, to afford safe anchorage during gales from the north and east; the other, called the ice-breaker, to protect shipping against northwesterly gales and the heavy drifting ice of the bay.

This project was completed in 1869, under aggregate appropriations, including the first for survey, of $2,192,103.70. The stone used in the work amounted to 892,528 gross tons, and varied from one-quarter of a ton to 7 tons in weight, the smaller constituting the bulk of the mass, the larger used to cover the exterior slopes.

As completed in 1869 the breakwater is 2,558 feet long, and the ice-breaker 1,359 feet long on top. The average width on top is 22 feet, and at base 160 feet. The top is from 12 to 14 feet above mean low water.

In 1882 a project was adopted for closing the gap between the breakwater and the ice-breaker by means of a random stone foundation with a concrete superstructure. The random stone foundation is to be brought to a height of 12 feet below low water, with a width on top of 48 feet.

The concrete superstructure is to have a width on bottom of 24 feet, rising to a height of 12 feet above mean low water, with a width on top of 12 feet. The estimated cost of this project was $675,000.

In 1883 and 1884 the project was modified by providing a foundation of brush mattresses for the random stone substructure, and omitting the construction of a pile bridge across the gap, which formed part of the project of 1882 for closing the gap.

From the beginning of the work, in 1822, to June 30, 1885, the total amount expended was $2,322,195.27, of which $132,066.22 was expended on the project of 1882 for closing the gap.

During the fiscal year ending June 30, 1886, $68,329.10 was applied to the delivery of 30,339 tons of stone in the substructure of the work.

It is proposed as funds, become available, to continue the work in progress.

July 1, 1885, amount available	$67,937 78
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	66,358 45
July 1, 1886, amount available	1,579 33
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	57,829 33
Amount (estimated) required for completion of existing project	418,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	200,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 9.)

10. *Rancocas River, New Jersey.*—The Rancocas is a comparatively large and important stream 200 yards wide at its mouth, and narrows to about 400 feet at a distance of 8 miles above. As is usual with rivers entering into the Delaware Bay and River, a bar exists at its mouth, difficult to treat effectively and cheaply on account of the liability of the cuts to close up unless protected by deflecting dikes. There is, however, a low-water navigable depth of nearly 8 feet over this bar at present.

Ths original project provided for a low water-channel from 150 to 200 feet wide and 6 feet deep at low water to Centreton, 7¼ miles above the mouth, and eventually a 5-foot low-water channel to Mount Holly, 5¾ miles above Centreton. The estimated cost of the whole was $82,000. The amount expended up to June 30, 1885, was $19,833.24. On that date a dike had been built from the head of Hamill's Island to the north bank of the river, and a 6½-foot low-water channel 150 feet wide cut through Coate's Bar.

The appropriation asked would be expended in carrying the improvement up-stream by dredging the shoals in the order in which they appear.

July 1, 1885, amount available	$166 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	66 67
July 1, 1886, amount available	100 09
Amount (estimated) required for completion of existing project	62,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 10.)

11. *Woodbury Creek, New Jersey.*—The lower part of Woodbury Creek, from its mouth to the Crown Point Road Bridge, is considered to have sufficient depth of water at high stages of the tide for the needs of navigation. The portion which should be improved is the reach extending from this bridge to the Broad Street Bridge in the town of Woodbury, the head of navigation. At low tide this portion of the creek is almost entirely devoid of water, but the range of tide being between 5 and 6 feet, small vessels can ascend at high stages.

The project of 1883 proposed to dredge a channel affording a high-water depth of 8 feet and a width of 40 feet from Crown Point Road Bridge to Broad Street Bridge in the town of Woodbury, at an estimated cost of $15,000. This channel when once made is to be maintained by the parties interested.

The sum of $450.31 was expended up to June 30, 1884, for a survey of the creek.

The partial dredging of a channel being of no commercial value, expenditures have been withheld to await further appropriation sufficient to complete the dredging as far as Woodbury.

July 1, 1885, amount available	$4,549 69
July 1, 1886, amount available	4,549 69
Amount (estimated) required for completion of existing project	10,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 11.)

12. *Mantua Creek, New Jersey.*—The original project for this improvement contemplates the construction of a low-water channel 10 feet deep and 80 feet wide at the mouth of the creek, which is to diminish to 4 feet in depth and 40 feet in width at the town of Mantua, situated some 11 miles from the mouth, at an estimated cost of $35,000.

The stream in its natural condition possesses good depth of water for a distance of 3 or 4 miles from the Delaware River, having a low-water depth of 9 feet throughout this distance. Above this, however, the channel depth slowly diminishes until at Mantua there is a low-water depth of only 2 feet.

No money has yet been expended on the work, and since whatever dredging done here would not be permanent, no further appropriation is recommended.

July 1, 1885, amount available	$3,000 00
July 1, 1886, amount available	3,000 00
Amount (estimated) required for completion of existing project	32,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 12.)

13. *Raccoon River, New Jersey.*—This river has a high-water width at its mouth of about 450 feet, gradually diminishing to 100 feet at Swedesborough, about 9½ miles up-stream. There is a good 4-foot low-water channel and a high-water channel of from 9 to 10 feet from the mouth of the river to more than half the distance to Swedesborough. The serious and extensive obstructions are found within 2 miles of that town. There are four bridges across the stream. Two of these are located at Bridgeport, about 2 miles above the mouth of the river, and the other two at Swedesborough. The lower one of the two latter is the Swedes-

borough Railroad Bridge, and barges can pass under it; the upper o is the Main Street Bridge, and is the head of navigation.

The project submitted with the report on the survey, dated Febru 26, 1883, contemplates making the navigation up to Main Street Brid in Swedesborough more safe and less difficult for the class of vess now navigating the stream by dredging, at an estimated cost of $18,0

The sum of $757.23 was expended up to June 30, 1883, for surve and nothing since, the balance on hand being held to await further propriation.

July 1, 1885, amount available	$2,242
July 1, 1886, amount available	2,242

Amount (estimated) required for completion of existing project	16,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 13.)

14. *Salem River, New Jersey.*—The original navigable capacity of th stream was 6 feet at low water over the bar in Salem Cove, and 3 to feet at low water on the shoals at Biddle's Landing.

The originally adopted project consisted in dredging an 8-foot lo water channel, as wide as the vessels needed, through the bar in Sale Cove. Subsequently the work was changed to the shoals in the can and river above the latter.

The amount expended to June 30, 1885, was $13,009.34. On th date a low-water channel 8 feet deep and 110 feet wide had been dredg through the bar in Salem Cove, and a channel 60 feet wide and from to 7 feet deep at low water had been dredged from the head of t canal to a point about 200 feet above Biddle's Landing.

Nothing was expended during the fiscal year ending June 30, 1886.

The estimated amount required to complete the work according the existing project, that is, to Hoxie's Landing, is $4,000. If the i provement is carried up to Sharptown, the amount would be $37,000.

July 1, 1885, amount available	$1,490 6
July 1, 1886, amount available	1,490 6

(See Appendix F 14.)

15. *Cohansey Creek, New Jersey.*—Cohansey Creek, in its original condition, was navigable to Bridgeton, 20 miles above its mouth, through tortuous channel of ample depth. The obstructions to its free navigatio were found at Bridgeton and at its mouth, where the creek discharged across a soft mud-bar without any well-defined channel. The gas and water mains of the city of Bridgeton cross the creek at Broad Street a a level of only 4 feet below low water, and prevent the use of any further deepening of the channel above them. In the event of the city authorities lowering the pipes to a proper depth, the amount required to complete the project by carrying a 6-foot low-water channel to th "Nail Works" Bridge would be about $5,500.

The original project contemplated the construction of a channel a Bridgeton 130 feet wide and 4 feet deep, at a total cost of $30,000 This was modified to reduce the width to 80 feet and to increase th depth at mean low water to 7 feet from the lower steamboat landing t the bridge, and above that point to 5 feet. This project was agai amended in June, 1880. It contemplates bringing the 7-foot low-wate channel from deep water below the lower steamboat landing upward a far as the Commerce Street Bridge, and thence to the "Nail Works Bridge, a low-water channel of 6 feet, the channel to be 100 feet wid at its lower end and to decrease to 50 feet at the upper bridge.

The total amount expended to June 30, 1885, was $35,489.27. At that date the 7-foot low-water channel had been widened and straightened, and it is now 90 feet wide between the upper and lower steamboat wharves, and 70 feet above that to the bridge.

No more money can be advantageously expended until the gas and water pipes are lowered or removed. If this is done, the amount that can be profitably expended during the fiscal year ending June 30, 1888, is $5,500, which would complete the improvement according to the existing project.

Amount (estimated) required for completion of existing project........	$5,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 15.)

16. *Removal of wrecks from Delaware Bay and River.*—There have been no operations during the past fiscal year under this appropriation, the removal of all wrecks having been made under the general provisions for "Removing sunken vessels or craft obstructing or endangering navigation."

July 1, 1885, amount available..	$2,420 97
July 1, 1886, amount available..	2,420 97

(See Appendix F 16.)

17. *Removing sunken vessels or craft obstructing or endangering navigation.*—During the past fiscal year the following wrecks were removed from the Delaware River under the provisions of section 4, act of June 14, 1880: The sloop Ann, from near the Deep Water Point range, off the lower part of New Castle, Delaware, and the steam canal-boat Thomas Carroll from near the intersection of the Schooner Ledge and Cherry Island flats ranges.

(See Appendix F 17.)

18. *United States Commission Advisory to the Board of Harbor Commissioners of Philadelphia, Pennsylvania.*—The United States Commission Advisory to the Harbor Commission of Philadelphia have had under consideration the establishment of the Port-Wardens' lines.

Plans were submitted for a Port-Wardens' line from the mouth of the Schuylkill to Bridesburg, which were approved by the Harbor Commission and formally adopted by the councils of the city of Philadelphia. This action, in connection with previous State legislation, has established the legality of the Port-Wardens' lines for this part of the Delaware River front. The commission have under consideration the plan for the definite Port-Wardens' lines between Bridesburg and the upper city limits, and pending the establishment of such lines, have, at the request of the Harbor Commission, prepared a chart showing a line beyond which no wharf should for the present be allowed to extend. The city councils have passed a resolution requesting the Board of Port Wardens not to grant permission to extend wharves beyond the line recommended.

A physical survey of the river is now in progress between Bridesburg and the upper limits of the city, for the purpose of obtaining the necessary data required for the definite establishment of the Port-Wardens' lines for this part of the river.

Besides the establishment of this line, the following work of the commission yet remains to be accomplished: The reference of the Port-Wardens' lines to fixed monuments; the establishment of Port-Wardens' the existing project, but is greatly in need of repairs in various directions. Those most to be recommended are the continuing of the dredging inside the harbor, so as to give throughout the entire area 18 feet at mean low water, to repair one crib, and to rebuild another, which is in constant danger of being destroyed, and to place about 100 cubic yards of riprap around the pier.

The amount that can profitably be expended during the fiscal year ending June 30, 1888, is $15,600. If this sum should be appropriated, it is proposed to expend it in dredging the harbor to a depth of 18 feet at mean low water, to rebuild one pier, repair another, and place riprapping around those piers exposed to strong currents.

Amount appropriated by act approved August 5, 1886 .... $5,000 00

Amount (estimated) required for completion of existing project....... 15,600 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 15,000 00
Submitted in complance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix G 3.)

4. *Duck Creek Delaware.*—The original condition of Duck Creek was a bar at the mouth, having 3 feet at ordinary low water, with nine shoals with a minimum depth of 2.5 feet in the channel between the bar and Smyrna, the head of navigation. The approved project was to construct a channel through the bar to 8 feet depth at mean low water and having in width not less than 100 feet, and the removal of the existing shoals as far as Smyrna to the same depth.

The amount expended to the close of the fiscal year ending June 30, 1885, was $10,000, in making a channel through the bar at the mouth of the creek, but the improvement was not permanent, and the channel soon filled up for want of a protecting work.

No work was ever done to remove the shoals between the mouth of the river and Smyrna. The navigation would be greatly improved if these shoals could be removed, by enabling vessels to pass between Smyrna and the mouth on any tide, and reach the deep water of Delaware Bay with high water, whereas it now takes several high tides to reach that point. The commerce on this stream is large and would seem to justify the removal of the shoals, but it is not believed to be sufficient for the expenditure necessary for the permanent improvement of the mouth. This plan has been adopted for the improvement of both the Saint Jones and Broadkiln rivers, and navigation has been greatly benefited thereby, and the tendency has been, as reported by captains of vessels sailing these rivers, since the removal of the shoals from the bed of these rivers, to increase the depth of water over the bar at the mouth. Nothing was done during the year ending June 30, 1886, for want of money.

The amount that can be profitably extended during the fiscal year ending June 30, 1888, is $6,000, and if appropriated will be applied to the removal of the shoals between Smyrna and the mouth of the river, to give a low-water navigation of 8 feet in depth.

Amount (estimated) required for completion of existing project......... $12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 6,000 00
Submitted in compliance with requirements of section 2 of river and harber acts of 1866 and 1867.

(See Appendix G 4.)

5. *Saint Jones River, Delaware.*—The obstructions to navigation in this river consist of a bar at its mouth with only 2 feet in depth at mean low water on it; from its mouth to Lebanon numerous shoals, over which

A later project was submitted and approved providing for a 15-foot w-water navigation from the entrance of the harbor to the Pulp Works ove the city of Wilmington, and from thence to the Delaware Railroad idge, a 12-foot low-water navigation; the width of the channel to be 0 feet from the entrance to Market Street Bridge, and from thence the Pulp Works 75 feet, and from that point to Delaware Railroad idge 50 feet.

This 15-foot and 12-foot navigation was to be obtained by dredging, nstructing a jetty at the entrance of the harbor, and the removal of a all quantity of rock near Third Street Bridge.

This project was amended in 1884, which provided for an additional ight to the jetty then already completed, and to extend it 322 feet in ngth into the Delaware River. It is thought that these additions to e jetty will check the unexpected eddying and counter-currents which use shoaling at some points more rapidly than before it was conucted; also dredging out the bar at the entrance uniting the 15-foot rves inside the harbor with the 15-foot curve of the Delaware River.

The amount expended to the close of the fiscal year ending June 30, 85, was $190,956.77, and at that date the harbor had a 15-foot navigan from its entrance to Market Street Bridge and from there to the lp Works a 12-foot navigation, excepting in the draw of Market Street idge where in some places only 8 feet of water existed.

The amount expended during the year ending June 30, 1886, is $3,927.22, d the result was the removal of a sunken crib off Lobdell's Canal and e two old light-house wharves at the entrance of the harbor, each of ich were obstructions and increased the difficulties of navigation by oking and jamming the floating ice during spring months; also the epening of the channel through the draw at Market Street Bridge to depth of 15 feet at mean low water, and a width of 80 feet.

The amount that can be profitably expended during the year ending ne 30, 1888, is $75,000, and if appropriated it is proposed to extend e jetty 322 feet and to continue the work on the project for a 15-foot vigation to the pulp works.

The amount estimated for the completion of the improvement is 47,634. It might be supposed that the amendment of 1884 to the oject for a 15-foot navigation would increase this estimate, but in the port of the Chief of Engineers for 1883, Part I, page 620, the estite of cost of this work is there increased, and it is thought the amount w estimated for the completion of the work is sufficient to do all that required, including the amendment and the work of removal of the crib and wharves.

y 1, 1885, amount available	$17,043 23
y 1, 1886, amount expended during fiscal year, exclusive of liabilities utstanding July 1, 1885	3,927 32
y 1, 1886, amount available	13,115 91
ount appropriated by act approved August 5, 1886	18,750 00
ount available for fiscal year ending June 30, 1887	31,865 91
Amount (estimated) required for completion of existing project	147,634 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	75,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix G 2.)

3. *Ice-harbor at New Castle, Delaware.*—This important harbor of uge was finished August 8, 1882. It is now complete according to

the existing project, but is greatly in need of repairs in various directions. Those most to be recommended are the continuing of the dredging inside the harbor, so as to give throughout the entire area 18 feet at mean low water, to repair one crib, and to rebuild another, which is in constant danger of being destroyed, and to place about 100 cubic yards of riprap around the pier.

The amount that can profitably be expended during the fiscal year ending June 30, 1888, is $15,600. If this sum should be appropriated it is proposed to expend it in dredging the harbor to a depth of 18 feet at mean low water, to rebuild one pier, repair another, and place riprapping around those piers exposed to strong currents.

Amount appropriated by act approved August 5, 1886	$5,000 00
Amount (estimated) required for completion of existing project	15,600 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in complance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 3.)

4. *Duck Creek Delaware.*—The original condition of Duck Creek was a bar at the mouth, having 3 feet at ordinary low water, with nine shoals with a minimum depth of 2.5 feet in the channel between the bar and Smyrna, the head of navigation. The approved project was to construct a channel through the bar to 8 feet depth at mean low water and having in width not less than 100 feet, and the removal of the existing shoals as far as Smyrna to the same depth.

The amount expended to the close of the fiscal year ending June 30, 1885, was $10,000, in making a channel through the bar at the mouth of the creek, but the improvement was not permanent, and the channel soon filled up for want of a protecting work.

No work was ever done to remove the shoals between the mouth of the river and Smyrna. The navigation would be greatly improved if these shoals could be removed, by enabling vessels to pass between Smyrna and the mouth on any tide, and reach the deep water of Delaware Bay with high water, whereas it now takes several high tides to reach that point. The commerce on this stream is large and would seem to justify the removal of the shoals, but it is not believed to be sufficient for the expenditure necessary for the permanent improvement of the mouth. This plan has been adopted for the improvement of both the Saint Jones and Broadkiln rivers, and navigation has been greatly benefited thereby, and the tendency has been, as reported by captains of vessels sailing these rivers, since the removal of the shoals from the bed of these rivers, to increase the depth of water over the bar at the mouth. Nothing was done during the year ending June 30, 1886, for want of money.

The amount that can be profitably extended during the fiscal year ending June 30, 1888, is $6,000, and if appropriated will be applied to the removal of the shoals between Smyrna and the mouth of the river, to give a low-water navigation of 8 feet in depth.

Amount (estimated) required for completion of existing project	$12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00
Submitted in compliance with requirements of section 2 of river and harber acts of 1866 and 1867.	

(See Appendix G 4.)

5. *Saint Jones River, Delaware.*—The obstructions to navigation in this river consist of a bar at its mouth with only 2 feet in depth at mean low water on it; from its mouth to Lebanon numerous shoals, over which

there is only 4 feet at mean low water, and from Lebanon to Dover, the head of navigation, 2.5 feet at low water. Many bends in the river also interfere with navigation. The original project for the improvement of this river was to give a 6-foot navigation by cutting a channel through the bar at the mouth 100 feet in width, to be protected by a jetty; to remove the shoals and make several cut-offs. The amount expended to the close of the fiscal year ending June 30, 1885, was $719.99.

The amount expended during the fiscal year ending June 30, 1886, is $11,546.08, and has resulted in giving a 6-foot navigation from the mouth of the river to Lebanon and a portion of the distance between Lebanon and Dover. Vessels are enabled now to go from Lebanon to the mouth of the river on any tide, and pass over the bar on high water, whereas before the improvement they were frequently detained by low water at each shoal.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is $10,000, and if appropriated will be applied to continuing the improvement by removing the shoals, cutting off points and bends which obstruct navigation.

The benefits to be derived from this improvement are to shorten the distance between Dover and the mouth of the river, and to lessen the time required by enabling vessels to navigate the river at any tide.

July 1, 1885, amount available		$14,162 11
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$11,546 08	
July 1, 1886, outstanding liabilities	1,122 44	
		12,668 52
July 1, 1886, amount available		1,493 59
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		11,493 59
Amount (estimated) required for completion of existing project		10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix G 5.)

6. *Mispillion Creek, Delaware.*—In its original condition this river had a width of about 90 feet at Milford, the head of navigation, increasing to 240 feet at its mouth. The entrance to Delaware Bay had a depth of 1½ feet at mean low water, and between the mouth and Milford are several shoals having a depth of from 4 to 5 feet on them. The originally adopted project was to make a 6-foot low-water navigation with a channel width of 40 feet through the bar at the mouth, and to remove the shoals from the bed of the stream to the same depth. The amount expended to the close of the fiscal year ending June 30, 1885, was $13,000, in removing the shoals from the bed of the river, which has been of benefit to the ship-building and commercial interests of this locality.

Nothing has been done during the year ending June 30, 1886, for want of appropriations.

The amount that can be profitably expended during the year ending June 30, 1888, is $3,500, and if appropriated it is proposed to continue the removal of the shoals between Milford and the mouth of the river to a depth of 6 feet at mean low water, which will be a further benefit to navigation by allowing vessels to go up and down the stream at any stage of the tide and lessening the time now required.

The amount expended during the year ending June 30, 1886, is $11,224.80, and the shoal near Watson's Island was dredged back a further distance of 200 feet, to a depth of 8 feet at mean low water. The effect of this work has been of great benefit and the tendency of the ice to gorge lessened.

The two important interests of the Susquehanna River below Havre de Grace, the navigation and fishery, are somewhat in antagonism, as the means deemed necessary for securing a permanent deeper channel in that section of the river, viz, jetties and other regulating works, are greatly opposed by those engaged in the fisheries.

The alternative was submitted to Congress, in the Annual Report of the Chief of Engineers for 1883, of appropriating at once $100,000 for these regulating works to be put in, to the detriment of the fishery interests, or to appropriate $20,000 annually for dredging.

Assuming the alternative adopted by Congress by appropriating $20,000 for this improvement in 1884, the amount that can be profitably expended during the fiscal year ending June 30, 1888, is $20,000. If appropriated, it is proposed to continue the work, under the adopted project for a 15-foot navigation below Havre de Grace, by redredging the two shoals to that depth, and to cut off as much more of the shoal near Watson's Island as the balance of the funds will permit.

July 1, 1885, amount available	$11,643 87
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,224 80
July 1, 1886, amount available	419 07
Amount appropriated by act approved August 5, 1886	6,000 00
Amount available for fiscal year ending June 30, 1887	6,419 07
Amount (estimated) required for annual dredging	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 10.)

11. *Chester River, at Kent Island Narrows, Maryland.*—The approved project was to reopen a channel, formerly existing between Chester River and Eastern Bay, which had been shut up by a solid causeway under the authority of the State of Maryland. This project was completed and an unexpended balance of $2,500, has remained since 1878.

No further work is deemed necessary. The channel opened seems to be of little use, and, as no steamers pass through, it has been gradually filling up.

July 1, 1885, amount available	$2,500 00
July 1, 1886, amount available	2,500 00

(See Appendix G 11.)

12. *Chester River, from Spry's Landing to Crumpton, Maryland.*—In its original condition only 6½ feet of water could be carried between these two places.

The originally adopted project was for dredging an artificial channel 120 feet wide and 8 feet deep at mean low water. This project was completed in July, 1883. No work has been done on this locality since that time.

The amount expended to June 30, 1885, was $13,000, which was the original estimate for the improvement.

(See Appendix G 12.)

13. *Corsica Creek, Maryland.*—The condition of this stream originally was such that navigation between Hooper's Wharf and the town of Centreville was kept up by the use of lighters.

The originally adopted project for the improvement was to construct a channel 100 feet wide and 8 feet deep at mean low water, from Hooper's Landing to the town of Centreville, with a turning basin at the head. The estimated cost was $30,000. To the close of the fiscal year ending June 30, 1885, $10,000 had been appropriated for this improvement, and a channel 8 feet deep at low water and 50 feet in width has been made from Hooper's Landing to within 344 feet of the County Bridge, the head of navigation. The channel was also straightened by cutting off a point of land near the town of Centreville, the right to which was given the United States free of cost. Steamers are able now to reach Centreville Landing, and lighterage is no longer necessary. Nothing was done during the fiscal year ending June 30, 1886, for want of funds.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is $10,000, and if appropriated it is proposed to apply the same to the continuance and completion of the improvement in accordance with adopted project.

The commerce of the creek is very large, and navigation has been greatly benefited by the improvement, as well as a saving in expense of lighterage.

July 1, 1885, amount available	$308 86
July 1, 1886, amount available	308 86
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,308 86
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 13.)

14. *Choptank River, Maryland.*—This river originally had a depth of about 9 or 10 feet of water, except at one point, as high up as Denton, where the mean rise of tide is about 2 feet. Between Denton and Greensborough, the portion on which the improvement has been made, the width varies from 100 to 650 feet, with a depth varying from 2 feet to 8 feet at mean low water.

The originally adopted project for the improvement of the river was for an 8-foot low-water channel, with a width of 75 feet, at a cost of $79,000. It was stated, however, that the cost would be much reduced if the depth was kept at 7 feet.

The total amount appropriated for this improvement to the close of the fiscal year ending June 30, 1885, was $20,000, and a 6-foot low-water navigation has been attained from Denton to Case's Wharf, and from thence to the town of Greensborough 5-foot low-water navigation has been made. The width of the artificial channel varies from 47 feet to 75 feet.

There were no operations during the fiscal year ending June 30, 1886.

The estimated amount required to complete the work of improvement in accordance with the adopted project is $47,000. The benefits expected by the completion of this improvement are, that a larger class of steamers and vessels will navigate this portion of the river, and freights reduced thereby. Denton and Greensborough are both thriving towns on the eastern shore of Maryland, and large quantities of grain, lumber, fruit, and other products are shipped from there to Baltimore by water.

A small steamer has already been put on this river between Denton and Greensborough, since the improvement has begun, and a larger steamer comes within 8 miles of the town of Greensborough.

July 1, 1885, amount available	$109 28
July 1, 1886, amount available	109 28
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,109 28
Amount (estimated) required for completion of existing project	47,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 14.)

15. *Wicomico River, Maryland.*—In the original condition, this river was only navigable to a point several miles below the town of Salisbury.

The originally adopted project for the improvement of this river was to give 7-foot low-water navigation in a channel about 70 feet in width for a distance of about 2 miles below Salisbury.

The project also included some dikes for the contraction of the waterway, and as a place behind which to deposit material removed from the channel.

The project approved for the expenditure of the appropriation of July 5, 1884, recommended an amendment to the original project by straightening and widening the channel from 85 to 100 feet.

The amount expended to the close of the fiscal year ending June 30, 1885, was $45,524.17, and a 7-foot low-water channel had been made to the town of Salisbury, with a width of 70 feet the entire distance, and from 85 to 100 feet in width, to within 2,217 feet of the town. Also a good turning-basin has been excavated near the town.

The amount expended during the fiscal year ending June 30, 1886, is $3,105.36, and the remaining portion of the channel, 2,217 feet, was widened to 85 and 100 feet to correspond to the balance of the artificial channel, which work completed the project.

No further improvement seems necessary to this river at present. The improvement made has been of great benefit to navigation, and placed Salisbury, Md., in direct communication with Baltimore by water.

July 1, 1885, amount available	$4,478 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,105 36
July 1, 1886, amount available	1,372 80

(See Appendix G 15.)

16. *Upper Thoroughfare, between Deil's Island and the mainland.*—This water-passage separates Deil's Island from the mainland of Somerset County, Maryland. At its eastward end this passage is an arm of Tangier Sound, of considerable width, narrowing and shoaling rapidly, and exposed to southwest storms.

The original project of this improvement was to provide a harbor of refuge for small vessels, and a place at which steamers could stop and bring the people and their abundant crops from the land and water into quick communication with the markets of Baltimore and Philadelphia by dredging an anchorage basin with an approach to deep water, and construct a breakwater for its protection from filling. The estimate of the cost of this improvement is $20,000. No work has been done as yet, as the funds available are inadequate to be applied advantageously.

The Maryland Steamboat Company, running from Baltimore, have a pier at Deil's Island.

July 1, 1885, amount available	$4,669 91
July 1, 1886, amount available	4,669 91
Amount (estimated) required for completion of existing project	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 16.)

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND, AND OF THE HARBOR OF ANNAPOLIS, MARYLAND.

Officer in charge, Lieut. Col. W. P. Craighill, Corps of Engineers.

1. *Channel to Baltimore, Maryland.*—The depth of this channel has been by successive steps increased from 17 feet at mean low water to 27 feet, with an average rise of tide of about 18 inches.

The project of improvement at first adopted and commenced in October, 1853, had for its object to give a channel 22 feet at mean low water with a width of 150 feet.

Little was done before the late war, but afterwards these dimensions were increased, a depth of 24 feet at mean low water being determined upon, with a width of channel ranging from 250 to 400 feet. This channel was completed in 1874, important changes of position having been given to a portion of it, by which the distance was materially lessened and the expense of maintenance decreased.

The object of the improvement was to permit the approach to Baltimore at mean low water of vessels drawing from 22½ to 23 feet, and at ordinary high water of vessels drawing 24 and 24½ feet.

The last appropriation previous to 1884 was in August, 1882, $450,000, there being none in 1883. This was expended in giving a depth of 27 feet in the Fort McHenry, Brewerton, and Craighill branches of the channel, and in the "cut-off" between the Brewerton and Craighill branches, by which last a saving of nearly a mile in distance was made, besides an improvement in direction and diminution in cost of maintenance. The width attained was, however, too little.

For want of funds the work of improvement was entirely suspended during the whole of the year ending June 30, 1886.

Advantage was taken of the absence of the dredges with their numerous attendant tugs and scows to make a thorough resurvey of the whole channel, the map of which has also been prepared.

The following are the widths of the respective branches of the channel June 30, 1886, with a depth of 27 feet at mean low water:

	Feet.
Craighill Channel	350
Cut-off Channel	300
Brewerton Channel	250
Fort McHenry Channel	250

Though the depth of 27 feet at low water has been reached, and seems to suffice for the present needs, the width is too little for easy or safe navigation by very large vessels, whose length is considerably greater than the width of the channel.

Up to June 30, 1886, the United States had expended $2,032,833.72, with the results indicated above. The city of Baltimore and the State of Maryland, chiefly the former, had contributed to the same object $584,000. The estimate below is for making the channel of a uniform width of 400 feet, which is still too little.

July 1, 1885, amount available	$30,846 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,052 97
July 1, 1886, amount available	24,793 44
Amount appropriated by act approved August 5, 1886	150,000 00
Amount available for fiscal year ending June 30, 1887	174,793 44
Amount (estimated) required for completion of existing project	80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	80,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 1.)

2. *Harbor of Annapolis, Maryland.*—An appropriation of $5,000 was made for this harbor June 14, 1880, and another of the same amount March 3, 1881. Until recently it had not been considered necessary or expedient to spend the money for reasons which have been fully stated in several preceding annual reports.

Information was received towards the close of 1885 that certain areas within the harbor had shoaled considerably, and the free movement of vessels was consequently much impeded. As soon as possible an examination was made of these shoal portions, much delay having been caused by the presence of ice, by high winds, &c.

The survey was finished late in April, and the map completed in May. It has been deemed necessary to dredge a part of the harbor to a depth of 20 feet, and a part to a depth of 14 feet, at mean low water.

The work was duly advertised and put under contract, and is to be finished in 1886.

There yet remain two bars with not more than 18½ feet on them at mean low water, which prevent large ships from passing from the bay into the deeper water (24 feet and more) of the Severn River, just abreast the Naval Academy.

The commerce of Annapolis is small. Its importance arises mainly from its being the seat of the Naval Academy, and from its strategic relations to the capital of the nation.

A project, suggested several years ago, for the removal of these bars by dredging a channel through them 24 feet deep at mean low water, with minimum width of 150 feet, is estimated to cost $66,000, which, if due regard be had for economy, should be provided in one sum and spent in a single season.

The rise of tide is about 1 foot.

July 1, 1885, amount available	$9,205 98
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	436 99
July 1, 1886, amount available	8,768 99
Amount (estimated) required for completion of existing project	66,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	66,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 2.)

3. *Removing sunken vessels or craft obstructing or endangering navigation.*—Notice was received in June, 1886, that there was a dangerous wreck near Cove Point, Chesapeake Bay. Upon investigation this vessel was found to be the schooner Oliphant, loaded with guano, bound from Baltimore. The necessary steps have been taken for her removal, in conformity to the law of June 14, 1880.

(See Appendix H 3.)

IMPROVEMENT OF THE HARBORS AT WASHINGTON AND GEORGETOWN, DISTRICT OF COLUMBIA—IMPROVEMENT OF THE POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA—IMPROVEMENT OF JAMES RIVER, VIRGINIA, AND OF SHENANDOAH RIVER, WEST VIRGINIA.

Officer in charge, Maj. Peter C. Hains, Corps of Engineers.

1. *Harbors at Washington and Georgetown, District of Columbia.*—The improvement of the harbors at Washington and Georgetown was first undertaken by the Government in 1870. Prior to that time the channel over the bar below Georgetown had only 8 feet of water at mean low tide. It was crooked, narrow, and difficult to navigate, so much so that up to 1870 the corporation of Georgetown had itself spent considerable money in dredging it. The channel over the bar below Long Bridge was less troublesome and somewhat deeper, but did not satisfy the wants of commerce.

The Washington Channel, or Harbor, along the city front from the northern limit of the arsenal to Long Bridge, had a ruling depth of only 10 feet at mean low tide. There were, besides, in the harbor of Georgetown, many projecting rocks with a depth of water over them that rendered navigation difficult and dangerous.

The original project looked to securing a depth of 16 feet at low tide to Georgetown, and along the wharves of the Washington Harbor from Arsenal Point to Long Bridge, and the removal of the most dangerous rocks that obstructed navigation in the harbor of Georgetown. When by act of August 2, 1882, Congress made an appropriation for improving the Potomac River in the vicinity of Washington, D. C., having reference to the improvement of navigation, the establishment of the harbor lines, and the raising of the flats, the project was modified to the removal of rocks in Georgetown Harbor to the depth of 20 feet at mean low tide, that being the depth to be given to the channel below.

The total amount expended on the improvement of Washington and Georgetown harbors up to the close of the fiscal year ending June 30, 1886, is $290,000. Of this amount, $260,821.45 has been expended in dredging. The remainder was expended in the removal of rocks in Georgetown Harbor. At the present time there is 20 feet of water at mean low tide in both harbors.

During the past year operations were confined to completing the removal of rocks in Georgetown Harbor, and in dredging the Georgetown Channel above Long Bridge. The removal of rocks was completed in November, 1885. The completion of this work left a balance of $11,316.17, which was applied to dredging the Georgetown Channel above Long Bridge, which was done under contract, the material being deposited on the Potomac Flats.

July 1, 1885, amount available		$18,425 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$16,909 79	
July 1, 1886, outstanding liabilities	1,515 88	
		18,425 67

(See Appendix I 1.)

2. *Potomac River at Washington, District of Columbia.*—The project for the improvement of the Potomac River in the vicinity of Washington, D. C., was adopted by act of Congress, passed August 2, 1882, and has for its object the improvement of the navigation of the river by widening and deepening its channels so as to accommodate vessels of the largest class that can reach Giesboro' Point, the establishment of harbor lines beyond which no obstructions, such as wharves, &c., should be built, and at the same time to fill and raise the marshes or flats in front of the city above overflow by the highest freshets, the material taken from the river in deepening and widening the channel to be used in filling the flats.

Before the improvement was commenced the flats or marshes in front of the city had become so offensive that parts of the city in their neighborhood were not habitable.

The channel to Georgetown was narrow and crooked, and had not sufficient depths to accommodate vessels sailing to and from that port; the Washington Channel, between Long Bridge and the Arsenal, was also inadequate to the wants of commerce. Vessels drawing 16 feet frequently grounded in the Georgetown Channel, and that depth was only maintained by frequent dredging.

The expenditures for the improvement have thus far amounted to $739,574.19, and have given a channel from Giesboro' Point to Georgetown over 300 feet wide and 20 feet deep (except where the depth has been somewhat reduced by the deposits of freshets), and a channel along the wharves from Washington Barracks 20 feet deep and from 200 to 350 feet wide. About 4,230,000 cubic yards of material have been deposited on the flats, raising an area of about 375 acres of marshes to a height of from 4 to 10 feet above mean low tide. The dredging during the past fiscal year was done by contract. The method used is that known as the "hydraulic." The material forming the bed of the river is stirred up by a system of plows at the base of the suction-pipe and, passing up through a centrifugal pump, is forced ashore through discharge-pipes, resting on pontoons.

The contract for dredging 1,000,000 cubic yards from the Washington channel is about completed. The material was all deposited on Section III, below Long Bridge. The contract for dredging the Virginia channel above Long Bridge (1,000,000 cubic yards) has been greatly retarded by freshets, ice, and stormy weather, but particularly by the amount of sand found in the material dredged. Good progress was being made when, on the night of the 19th of June, 1886, the best of the three dredges on the work was destroyed by fire.

The contract for dredging the Virginia Channel below Long Bridge, and a portion of the Tidal Reservoir (700,000 cubic yards) has progressed satisfactorily, and is now near completion.

The past year has been noted for the great number of freshets. These have retarded work, and have filled up to some extent the dredged channels. The failure to make an appropriation in 1885 has also been of great detriment to the work. It is of the utmost importance that large appropriations should be made in the early stages of a work of this character and magnitude. It is now in such a stage of progress that it is liable to, and during the past winter received, great damage from freshets. It should be pushed rapidly to a point nearer completion.

Provision should be made at an early day for retaining-walls to the sewer canal. An estimate was submitted in a former report. The estimated cost of such walls, built of concrete, would be about $208,144. There is little current in this canal; the level rises and falls with the tide. It receives, however, a large portion of the sewage of the city, which is pushed out in the river only by the continuous additions it receives. The plan of improvement contemplates the construction of a small tidal reservoir of about eight acres near the head of the sewer canal. Such a reservoir can be made to discharge about 1,000,000 cubic feet of water into it at each ebb tide; and this amount of fresh water discharged into the canal at proper intervals, daily, will ameliorate its present offensive condition, but as the city grows larger, and the quantity of sewage greater, it will only be a partial remedy. It is understood that the District authorities propose to establish a pumping station at the foot of Seventeenth street, and pump the sewage far out into and down the river—the canal to receive only the discharge from the sewer during a heavy rainfall. Such an arrangement is entirely practicable, and, it is believed, would solve this sewage problem in a satisfactory manner.

The officer in charge of this improvement reports that the time has now come when something should be done in regard to Long Bridge. The Board of Engineers that recommended the present plan of improvement stated in its report that "the Long Bridge should be rebuilt at an early period during the progress of the improvements." No plan can be made satisfactory while this bridge remains a serious obstruction to the flow of water beneath it. The riprap stone placed around the piers for their protection, together with the piers themselves, form a partial dam across the river, obstructing its flow, and will eventually cause a gradual deposit of sediment in the river above it. When the upper end of Washington Channel is closed, as it is intended to be, provision must be made in the Virginia Channel for discharging the freshet water that now passes through both. This cannot be done under the present bridge. It should, therefore, be rebuilt on piers with greater spans.

The sum of $700,000 can be profitably expended during the fiscal year ending June 30, 1888. If this sum be appropriated it will be expended in continuation of the work, in accordance with the approved project, in dredging the Virginia and Washington channels and filling Sections I, II, and III, in dredging the Tidal Reservoir, and building the inlet and outlet gates.

July 1, 1885, amount available		$358,027 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$197,602 12	
July 1, 1886, outstanding liabilities	38,188 75	
		235,790 87
July 1, 1886, amount available		122,237 06
Amount appropriated by act approved August 5, 1886		375,000 00
Amount available for fiscal year ending June 30, 1887		497,237 06
Amount (estimated) required for completion of existing project		1,441,365 00
Amount that can be profitably expended in fiscal year ending June 30, 1858		700,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I 2.)

3. *James River, Virginia.*—When the improvement of the James River was regularly undertaken by the Government, the navigation was obstructed by sunken vessels, by remains of military bridges, and by other obstructions purposely put in the river during the late war to prevent the national fleet from approaching too close to Richmond.

There were, besides, other material obstructions. Rocketts' Reef and Richmond Bar had only 7 feet of water at mean low tide; from Warwick Bar to Richmond the channel was crooked and obstructed by dangerous rocks and ledges; the Dutch Gap Cut-off was not then open and the river was in a poor condition as regards its availability for commercial purposes.

The original project for improvement was to secure a depth of 18 feet at full tide (corresponding to 14.5 feet at low tide) to Richmond, with a channel width of 180 feet. This project had reached an advanced stage of progress when Congress, by act approved July 5, 1884, adopted the project looking to 22 feet at mean low tide from the sea to Richmond, the width to be 400 feet from the sea to City Point, 300 feet from thence to Drury's Bluff, and 200 feet from thence to Richmond.

Operations during the past year have been restricted chiefly to an endeavor to maintain the condition of affairs that existed at the beginning of the fiscal year. The failure of the river and harbor bill of 1885 rendered the undertaking of new work impracticable.

The year has been remarkable for the frequency of high freshets. These have caused deposits of sand and silt, which had to be immediately removed. The total expenditures of the Government up to the close of the fiscal year 1886, on the improvement of this river, were $812,440.73. In addition to that the city of Richmond has expended $444,696.45.

The results of these expenditures may be stated as follows: Swan Point Shoal, where the depth had only been 16.5 feet at mean low tide, was deepened to 20 feet. This increase of depth adds a foot to the available depth of the river from its mouth to Kingsland Reach, a distance of 98 miles. The Dutch Gap Cut-off, which was of no use to navigation, has been widened to 300 feet, with a depth of about 18 feet, shortening the distance to Richmond 5½ miles. From Drury's Bluff to the ship-locks at Richmond the depth has been increased from 7 feet at low tide to the present depth of about 13.5 feet at low tide.

It is proper to add that a river subjected to such freshets as the James will require an annual expenditure to maintain the depth that is to be made. Experience can alone determine what that amount will be, but it is thought that not less than $15,000 will be required annually, depending on the number and height of the freshets.

The light sediment held in suspension will be carried far down the river, and the greater part deposited in places where it will do no harm; but the sand and gravel rolled along the bottom, the amount of which is large, will drop in the upper section of the river, and must be removed or it will cause an obstruction to navigation.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is put at $400,000. This is less than one-tenth the estimated cost of the entire project.

July 1, 1885, amount available	$19,256 22
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	16,696 95
July 1, 1886, amount available	2,559 27
Amount appropriated by act approved August 5, 1886	112,500 00
Amount available for fiscal year ending June 30, 1887	115,059 27
Amount (estimated) required for completion of existing project	4,263,570 45
Amount that can be profitably expended in fiscal year ending June 30, 1888	400,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 3.)

4. *Shenandoah River, West Virginia.*—Congress, by act of June 14, 1880, made an appropriation of $15,000 for improving the Shenandoah River, West Virginia. By act of March 3, 1881, an additional appropriation of $2,500 was made for the same object. A proviso was added to the latter act, to the effect that neither of these appropriations shall be expended "until any corporate rights or franchises that may exist over said river shall have been relinquished to the United States, to the satisfaction of the Secretary of War." This condition has been complied with.

The project for the improvement has for its object the rebuilding of the locks, dams, and chutes of the navigation company, so as to secure a down-stream navigation of about 18 inches. At the present time there is practically no commerce to be benefited by this improvement, and whether any would be built up by it is a question. Congress, by act of July 4, 1884, sold the sites of the lower locks that would be needed in this improvement, and with them all the water privileges at Harper's Ferry. The right to use a portion of the water to operate these locks, and the sites of the locks themselves, would, therefore, have to be purchased again by the United States. The question has now been raised, Can the United States undertake this improvement in view of the late act authorizing the sale of the Harper's Ferry property?

Under the circumstances, and in view of the fact that there does not appear to be any commerce to be benefited by the improvement, further legislation is asked.

July 1, 1885, amount available	$16,083 40
July 1, 1886, amount available	16,083 40

(See Appendix I 4.)

IMPROVEMENT OF THE HARBORS AT BRETON BAY AND SAINT JEROME'S CREEK, MARYLAND—OF THE CHANNEL AT MOUNT VERNON—OF RAPPAHANNOCK RIVER, AND YORK RIVER, VIRGINIA—OF TRIBUTARIES OF THE LOWER POTOMAC, AND OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

Engineer in charge, Mr. S. T. Abert, United States Agent; Supervising Engineer, Lieut. Col. W. P. Craighill, Corps of Engineers.

1. *Channel at Mount Vernon, Virginia.*—Previous to the commencement of this improvement there was a depth of but 4 feet at low water over the wide flat between the wharf at Mount Vernon and the main channel of the Potomac River, a distance of 1,900 feet.

The present project for improvement was adopted in 1879, the object being to excavate a channel from deep water of the Potomac River to the wharf at Mount Vernon, which should have a width of 150 feet, and a navigable depth of from 6 to 7 feet at low water, with turning-basin at the wharf. The amount expended to the close of the fiscal year ending June 30, 1882, was $8,442.86, which resulted in securing a channel 145 feet wide, with a depth varying from 7 to 9 feet from the Potomac Channel to the wharf, and a circular turning-basin at the wharf of the same depth, with a radius of 150 feet.

No recent examination has been made, but the Superintendent at Mount Vernon reports that the steamer, drawing 4½ feet, finds great difficulty in making the turn at the pier, and the engineer in charge believes that $5,500 will be necessary for widening the channel, enlarging the turning-basin, and removing the silt which has been deposited in the cut, and that this sum will complete the proposed plan of improvement.

July 1, 1885, amount available	$57 14
July 1, 1886, amount available	57 14

Amount (estimated) required for completion of existing project	5,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 1.)

2. *Neabsco Creek, Virginia.*—The obstruction to navigation in this stream consisted of a wide flat at the mouth, about 1½ miles in length, over which but 2¼ feet could be carried at low water, and several short bars in the upper part of the creek where the channel is narrow and tortuous.

The present project was adopted in 1881, and contemplated the excavation of a channel through the bars, 100 feet wide and 7 feet deep at low water, from the Potomac River to Atkinson's Upper Landing (including a channel to Atkinson's Lower Landing and Willis's Wharf), a distance of about 14,800 feet.

The amount expended to the close of the fiscal year ending June 30, 1884, was $4,942.73, which resulted in securing a channel 50 feet wide, and from 4 to 5 feet deep at low water, from the Potomac River to a point 1,800 feet above Willis's Wharf, where the creek is narrow and has a sufficient depth, although other bars still exist above this point. Twenty thousand dollars will complete the improvement as far as seems to be needed at the present time.

July 1, 1885, amount available	$57 27
July 1, 1886, amount available	57 27

Amount (estimated) required for completion of existing project	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 2.)

3. *Breton Bay, Leonardtown, Maryland.*—The harbor of Leonardtown, at the upper end of Breton Bay, prior to the commencement of the present improvement, had a least depth of 5 feet at low water, which was insufficient for the passage of steamers to and from the Leonardtown Wharf. The bar which extended to the 9-foot curve in the bay was about 1 mile in length.

The present project for the improvement was adopted in 1878, the object being to excavate a channel 150 feet wide and 9 feet deep between the 9-foot curve in the bay and Leonardtown Wharf.

The engineer in charge recommends increasing the width of the channel to 200 feet, and enlarging the basin to a length of 800 feet, and a width of 400 feet. The depth should not be less than 10 feet at low water.

Up to June 30, 1885, $22,950.49 was expended in removing 131,358 cubic yards of material. The channel was at that time 115 feet wide and from 9 to 10 feet deep.

The appropriation recommended is for the object of dredging a permanent channel to the Leonardtown Wharf.

Leonardtown is one of the landings of the Baltimore and Potomac River boats.

July 1, 1885, amount available	$49 51
July 1, 1886, amount available	49 51
Amount appropriated by act approved August 5, 1886	6,500 00
Amount available for fiscal year ending June 30, 1887	6,549 51

Amount (estimated) required for completion of existing project	19,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 3.)

4. *Nomini Creek, Virginia.*—This stream is an important tributary of the Potomac, 82 miles below Washington, draining a large area of productive country.

Navigation was obstructed by a bar of sand and oyster shells at its mouth, over which but 3 feet could be carried at low water, and the danger in passing the bar was further increased by the cross-tide and an exceedingly rapid current. The length of the bar to the 9-foot curve in Nomini Bay is 5,700 feet. After passing the bar 8½ feet can be carried to Nomini Ferry, 3 miles above the mouth.

The engineer in charge recommends the enlargement of the width from 150 to 200 feet; also to dredge a training-channel and to sink a mattress for the purpose of diverting a cross-current detrimental to the integrity of the main channel and obstructive to steamers which enter it. The amount recommended in 1885 for this purpose was $30,000.

The landings in Nomini Creek are the most important of the Baltimore and Potomac River boats.

The amount expended to June 30, 1886, was $32,500, which resulted in securing a channel 100 feet wide and 9 feet deep from the 9-foot curve in the bay to White Oak Point, a distance of 4,400 feet.

Amount (estimated) required for completion of existing project	$30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 4.)

5. *Harbor at entrance of Saint Jerome's Creek, Maryland.*—Saint Jerome's Creek enters the Chesapeake Bay 91 miles south of Baltimore and 6 miles north of Point Lookout. The outer bar in the bay has a length of 2,193 feet from the ninth-foot curve in the bay to Corsey's Point in the creek. The least depth of water on it before improvement was 2.8 feet. The average depth in the channel to the ponds used by the Fish Commission for hatching oysters was one-half foot. The length of the inner channel to the wharf of the Fish Commission is 3,742 feet.

The project for the improvement of this harbor was adopted in 1881, and contemplated dredging a channel 100 feet wide and 9 feet deep at low-water through the outer bar at the mouth of the creek, and a channel 40 feet wide and 6 feet deep through the south prong of the creek, the material therefrom to be thrown up in a dike, if practicable, so as to form a pond of a portion of this south prong for the purposes of the United States Fish Commission.

This harbor is situated at a desirable point for a refuge for oyster-boats.

Up to June 30, 1885, $20,289.37 was expended, and during the fiscal year ending June 30, 1886, $3,779.10 have been expended, making a total, to June 30, 1886, of $24,068.47.

July 1, 1885, amount available		$6,210 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,739 10	
July 1, 1886, outstanding liabilities	40 00	
		3,779 10
July 1, 1886, amount available		2,431 53

Amount (estimated) required for completion of existing project	26,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	18,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 5.)

6. *Rappahannock River, Virginia.*—The distance from Fredericksburg to the mouth of the river is 106½ miles.

The present project for the improvement of this river was adopted in 1871 and modified in 1879, the object being to provide a channel 150 feet wide and 10 feet deep through the bar at Fredericksburg, channels 100 feet wide and 10 feet deep through the bars between Fredericksburg and Port Royal, and channels 200 feet wide and 15 feet deep through two bars between Port Royal and Tappahannock, where a larger class of vessels should be provided for.

Between March 3, 1871, and June 30, 1879, $90,500 was expended on the first project.

The amount expended on the present project from June 14, 1880, to June 30, 1886, is $75,898.70. This expenditure has resulted in securing, by means of dredging at various times and the construction of longitudinal and spur dikes, navigable channels at Fredericksburg, Pollock's, Bernard's, Pratt's, Spottswood, Castle's Ferry, and Farley Vale bars, extending over a distance of 12.6 miles.

July 1, 1885, amount available		$11,554 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$10,154 83	
July 1, 1886, outstanding liabilities	298 56	
		10,453 39
July 1, 1886, amount available		1,101 30
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		21,101 30

Amount (estimated) required for completion of existing project	194,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 6.)

7. *Totusky River, Virginia.*—The obstructions to the navigation of this river consisted of two bars, one at its mouth, which forms a part of the wide flat between the outlet of the river and the navigable channel of the Rappahannock, having a least depth of 4½ feet, and the other about 2½ miles above the mouth, known as Booker's Bar, having a ruling depth of 3 feet. The improvement of Booker's Bar is needed for purposes of navigation.

Ten thousand dollars have been appropriated for this work up to August 2, 1882. This sum has been expended in building a longitudinal dike 2,117 feet in length, the effect of which has been to scour out the channel to a depth of 3½ feet at low water, but this action is slow in its results. The channel should be dredged if prompt improvement of the navigation is desirable. For this object $12,000 will be required.

July 1, 1885, amount available	$400 82
July 1, 1886, amount available	400 82

Amount (estimated) required for completion of existing project	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 7.)

8. *Urbana Creek, Virginia.*—This creek is a tidal tributary of the Rappahannock, which it enters 91 miles below Fredericksburg, Va.

Prior to the commencement of this improvement the navigation was obstructed by a bar at the mouth, over which but 6 feet of water could be carried.

The present project was adopted in 1879, the object being to excavate a channel through this bar 150 feet wide and 10 feet deep at low water. The amount expended up to June 30, 1884, was $15,431.41. No appropriation has since been made. The expenditure resulted in securing a channel through the outer bars of 10 feet in depth at low water and a width of 120 feet at the narrowest part, with the ends of the channel widened for facility in entering.

A turning basin 200 feet wide, 300 feet long, and 10 feet deep has also been made at Urbana Wharf; and a channel of approach within the creek 1,090 feet long, 80 feet wide, and 10 feet deep at low water. This is one of the landings of the Baltimore and Norfolk boats.

The engineer in charge asks, for the completion of this work, an appropriation of $6,000 for the year ending June 30, 1888.

July 1, 1885, amount available	$68 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	40 00
July 1, 1886, amount available	28 59

Amount (estimated) required for completion of existing project	6,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 8.)

9. *Mattaponi River, Virginia.*—This stream empties into York River, at West Point, Va. It is navigable for 56 miles.

Previous to the commencement of this improvement, the Mattaponi River was obstructed by numerous bars and by snags, wrecks, and overhanging trees. The object of the first project for improvement, adopted in 1880, was to provide a channel 40 feet wide and 5½ feet deep at low water, by the removal of snags, drift-logs, wrecks, and overhanging trees, and by dredging through the bars.

The amount expended to June 30, 1885, was $6,023.80, and during the year ending June 30, 1886, $174 have been expended, making a total to June 30, 1886, of $6,197.80. This sum was expended in snagging operations and in the removal of wrecks, logs, and overhanging trees for a length of river of about 24 miles.

The engineer in charge recommends making a channel through Robinson and Latane's bars, with a width of 40 feet at bottom and a depth of 6 feet at low water. The cost of this improvement would be $31,000 in addition to the amount available for the fiscal year ending June 30, 1887.

July 1, 1885, amount available	2,276 20
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	174 00
July 1, 1886, amount available	2,102 20
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	7,102 20
Amount (estimated) required for completion of existing project	31,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 9.)

10. *Pamunky River, Virginia.*—This stream empties into York River at West Point, Va. Its navigable length is 80 miles.

The present project for improvement was adopted in 1880, the object being to provide a channel 40 feet wide and from 3 to 5 feet deep from Hanovertown to Newcastle ferry, a distance of 9 miles, and 100 feet wide and 7 feet deep at low water on the lower bars.

The work can be prosecuted economically if the entire sum required for completion is appropriated for the fiscal year ending June 30, 1888.

The total expenditure to June 30, 1886, is $5,743.61.

July 1, 1885, amount available	$1,876 39
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	120 00
July 1, 1886, amount available	1,756 39
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	6,756 39
Amount (estimated) required for completion of existing project	15,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 10.)

11. *York River, Virginia.*—This is a large tidal tributary of the Chesapeake Bay, into which it empties about 16 miles in a line north of Fortress Monroe. It is formed by the Mattaponi and Pamunky rivers, and has a deep, navigable ship-channel for a distance of 41 miles.

The navigation of the river prior to the commencement of the present improvement was obstructed by a bar at the mouth of Potopotank Creek, having a least depth of 19 feet at low water, and a bar about 8½ miles above, at West Point, Va., having a least depth of 14 feet.

The present project was adopted in 1880, the object being to provide a channel, by dredging, 22 feet deep and 200 feet wide (to be increased afterwards to 400 feet wide) through the bars, and also a basin of the same depth at the wharves at West Point.

The first appropriation ($10,000), made June 14, 1880, was applied to the improvement of the Potopotank Bar, through which a channel 105 feet wide and 22 feet deep was secured by dredging.

The appropriations since 1880 have been applied to dredging the bar at West Point.

The amount expended up to June 30, 1885, was $67,833.31, and during the fiscal year ending June 30, 1886, $10,847.30 have been expended; making a total to June 30, 1886, of $78,680.61.

July 1, 1885, amount available		$12,166 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$10,764 69	
July 1, 1886, outstanding liabilities	82 61	
		10,847 30
July 1, 1886, amount available		1,319 39
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		20,069 39

Amount (estimated) required for completion of existing project	157,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 11.)

12. *Chickahominy River*, *Virginia.*—This river is navigable for 37 miles. The present project was adopted in 1878, the object being to dredge channels 100 to 150 feet wide through Binn's, Old Fort and Windsor Shades bars to a depth of not less than 8 feet at low water, and to remove snags, logs, &c., from points above Windsor Shades. The least depths on these bars, prior to the commencement of the improvement, were from 4 to 5 feet at low water.

The appropriations, amounting to $15,000, have been expended, and resulted in securing a channel through Binn's Bar, 150 feet wide and 8 feet deep; through Windsor Shades and Old Fort bars, 100 feet wide and 8 feet deep, and through the bar at the mouth of the river, 90 feet wide and 14 feet deep at low water.

For the completion of the project for the improvement of the upper part of the river $1,000 are still required, and for completing the project for improving the bar at the mouth an appropriation of $13,000 was recommended in the report for the year ending June 30, 1885.

Amount appropriated by act approved August 5, 1886	$4,000 00

Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 12.)

13. *Staunton River*, *Virginia*, *between Randolph Station and Brook Neal.*—The length of the Staunton is 200 miles. It unites with the Dan at Clarksville, and, thence to Albemarle Sound; the stream thus formed is called Roanoke River.

The present project for the improvement of this river between Randolph Station, on the Richmond and Danville Railroad, and Brook Neal, 31 miles above, was adopted in 1879, the object being to secure a navigable channel, not less than 35 feet wide and 2 feet deep at low water, through the various ledges and sand-bars which obstruct navigation, with a slope of water-surface at rapids not greater than 10 feet to the mile.

The amount expended to June 30, 1885, was $25,069, and during the fiscal year ending June 30, 1886, $1,725.38 have been expended, making a total to June 30, 1886, of $26,794.38.

July 1, 1885, amount available		$2,431 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,695 38	
July 1, 1886, outstanding liabilities	30 00	
		1,725 38
July 1, 1886, amount available		705 62
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,705 62
Amount (estimated) required for completion of existing project		36,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix J 13.)

14. *Staunton River, Virginia, between Brook Neal and Pig River.*—The distance between Brook Neal and Pig River is 52 miles, and the average fall per mile is 4.3 feet.

The present general project for the improvement of this part of the river was adopted in 1882, the object being to secure a navigable channel for bateaux not less than 14 feet wide and from 1½ to 2 feet deep at low water, with a slope of water-surface at rapids not greater than 10 feet to the mile.

The amount expended to June 30, 1884, was $1,894.79, which resulted in the improvement of navigation through the worst shoals in a distance of 15 miles.

July 1, 1885, amount available	$105 21
July 1, 1886, amount available	105 21
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,105 21
Amount (estimated) required for completion of existing project	27,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix J 14.)

15. *Dan River, between Madison, North Carolina, and Danville, Virginia.*—The distance by the river from Madison to Danville is 49.81 miles and the descent 2.82 feet per mile.

The object of the first project for this improvement, adopted in 1880, was to provide a channel for navigation not less than 35 feet wide, but it was afterward modified to a channel of not less than 16 feet wide and 2 feet deep in the rapids at low water.

The amount expended to June 30, 1885, was $28,111.99, and during the fiscal year ending June 30, 1886, $1,739.86 were expended, making a total to June 30, 1886, of $29,851.85. This expenditure has resulted in the improvement of 5½ miles of the river above Danville, and about 13 miles of the river have been freed from serious obstruction by this work.

The officer in charge reports that $5,000 will be required to complete the work, and that this sum could be profitably expended during the fiscal year ending June 30, 1888.

The work was to have been completed in three years, but has extended through seven, rendering it necessary to meet the contingent expenses for four years more than was intended.

July 1, 1885, amount available		$2,368 01
July 1, 1886, amount expended during fiscal year, exclusive of liabiliities outstanding July 1, 1885	$1,699 86	
July 1, 1886, outstanding liabilities	40 00	
		1,739 86
July 1, 1886, amount available		648 15
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,648 15
Amount (estimated) required for completion of existing project		5,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		1,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J 15.)

16. *Roanoke River, North Carolina.*—The first project for the improvement of this river was submitted in 1871, the object being to improve navigation by the removal of rocks near Weldon and Halifax, and all wrecks, snags, and overhanging trees at various other points, and dredging channels through the numerous bars and shoals. A part only of this project was adopted.

The amount expended under the first project to June 30, 1884, was $45,000.

The first appropriation under the present project of $5,000, made August 2, 1882, was expended in repairing two dikes at Indian Highland Bar. A survey was also made to ascertain the changes which had taken place since 1871, and a report was submitted.

The appropriation of July 5, 1884 ($3,000), was not expended because insufficient to prosecute the work economically.

The engineer in charge recommends that the operations should be limited, for the present, to the building of snag-boats, the removal of snags, and to the careful examination of certain bars. This work will, when accomplished, effect a much needed improvement.

July 1, 1885, amount available	$3,300 24
July 1, 1886, amount available	3,300 24
Amount appropriated by act approved August 5, 1886	20,000 00
Amount availnble for fiscal year ending June 30, 1887	23,300 24

(See Appendix J 16.)

17. *French Broad River, North Carolina.*—The first project for the improvement of this river was adopted in 1878, the object being to secure a channel 35 feet wide and not less than 2½ feet deep at low water between Brevard and Big Buck Shoals, a distance of 31.61 miles.

The amount expended to June 30, 1882, was $37,780.22, with which expenditure the following results were attained: A survey of the river between Brevard and Big Buck Shoals; the improvement of the various shoals and rapids by means of rock and gravel excavation; and the construction of wing-dams for a distance of 26 miles below Brevard.

The act of August 2, 1882, appropriated $5,000 for improving the river "from Smith's Bridge up." A survey from Smith's Bridge (near Asheville) to the foot of Long Shoal, a distance of 12.09 miles, was made in 1882, and a project adopted for securing a channel 30 feet wide and not less than 2½ feet deep at low water for this distance. The estimates amounted to $76,000. In the fiscal year ended June 30, 1884, this part of the river was improved for a distance of 4½ miles above the bridge, under a special act of appropriation.

If Congress direct the improvement between Brevard and Big Buck Shoals, $8,000 is required; and for continuing the improvement between Long Shoal and Smith's Bridge, $25,000.

The amount expended to June 30, 1885, was $42,788.23, and during the fiscal year ending June 30, 1886, $52 have been expended, making a total to June 30, 1886, of $42,840.23.

July 1, 1885, amount available	$211 77
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	52 00
July 1, 1886, amount available	159 77
Amount (estimated) required for completion of existing project	79,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J 17.)

18. *Aqueduct Bridge over the Potomac at Georgetown, District of Columbia.*—To enable a compliance with a resolution of the Senate of February 25, 1866, Mr. Abert was charged with an examination of the condition of this bridge, especially as to its safety for ordinary travel when the aqueduct is filled with water. His report thereon was transmitted to the Senate May 12, and printed as Senate Ex. Doc. No. 138, Forty-ninth Congress, first session.

(See also Appendix J 18.)

IMPROVEMENT OF THE HARBOR AT NORFOLK, VIRGINIA—APPROACH TO NORFOLK HARBOR, VIRGINIA—CURRITUCK SOUND—COANJOK AND EDENTON BAYS, AND NORTH RIVER BAR, NORTH CAROLINA—IMPROVEMENT OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

Officer in charge, Capt. F. A. Hinman, Corps of Engineers. Supervising Engineer, Lieut. Col. W. P. Craighill, Corps of Engineers.

1. *Harbor at Norfolk, Virginia.*—The project for improvement, adopted in 1877, was to deepen and widen the channel at the mouth of the Southern Branch and along the Berkley and Portsmouth flats, in the harbor proper, and, for the approaches, to dredge a channel 500 feet wide and 25 feet deep at ordinary low water through the bars at the Western Branch and Sewall's Point.

The revised project of 1885 is as follows: 1. To secure a channel not less than 25 feet deep and 500 feet wide at ordinary low water, by dredging, from the deep water of Hampton Roads to Norfolk and the United States navy-yard on the Southern Branch, and also to secure a channel in the Eastern Branch, at the same stage, not less than 22 feet deep, with a width at least 300 feet at the Norfolk and Western Railroad Bridge, and gradually increasing to about 700 feet at its mouth, by dredging between said points; and, 2. To ultimately dredge the entire area bounded by lines parallel to and 75 feet from the Port-Warden lines to a depth not less than 25 feet, at ordinary low water, from Fort Norfolk to the United States navy-yard, and not less than 22 feet deep from the mouth of the Eastern Branch to Campostella Bridge, and to construct a bulkhead at Berkley Flats.

With slight modifications all operations have been conducted in accordance therewith. The amount expended to June 30, 1885, was $383,032.81, which resulted in a channel at least 25 feet deep and not less than 200 feet wide at ordinary low water from the deep water of Hampton Roads to the United States navy-yard, and also a channel at least 22 feet deep and not less than 200 feet wide at same stage in the Eastern Branch up to the Norfolk and Western Railroad Bridge.

The former channel at Sewall's Point has contracted somewhat, and has shoaled in places to 24 feet; at the mouth of Southern Branch it has shoaled to 24 feet for a distance of 700 feet. The latter channel has deteriorated slightly. The easterly side of the cut through Sewall's Point Bar should be buoyed every 1,200 feet to mark it properly.

There was expended in the fiscal year ending June 30, 1886, $113.53, which was applied to contingencies.

Since the original estimates were made for this harbor the conditions upon which they were based have changed very materially, owing to increased commerce necessitating more wharves and anchorage-ground. The aggregate appropriations exceed the original estimates slightly, but expenditures have been made in localities not originally contemplated.

There will be but a small balance on hand at the close of the fiscal year ending June 30, 1887.

To entirely and permanently complete this work, so far as can be foreseen, will require the expenditure of $507,744.56, and this amount can be profitably expended in the fiscal year ending June 30, 1888, in the general improvement of the harbor and its approaches by dredging, and the construction of a bulkhead. The portion of the approach to the harbor between Lambert's Point and Fort Norfolk is not included herein as it is the subject of the following report.

July 1, 1885, amount available	$2,000 94
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	113 53
July 1, 1886, amount available	1,887 41
Amount appropriated by act approved August 5, 1886	50,000 00
Amount available for fiscal year ending June 30, 1887	51,887 41
Amount (estimated) required for completion of existing project	457,744 56
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 1.)

2. *Approach to Norfolk Harbor and the United States (Norfolk) Navy-yard, between Lambert's Point and Fort Norfolk.*—The original condition of the channel was good, with the exception of a bar opposite the mouth of the Western Branch, on some parts of which the ruling depth was only about 15 feet at mean low water.

The project for the improvement adopted in 1878 was to dredge this bar for a distance of 4,800 feet to a width of 500 feet and a depth of 25 feet at mean low water.

The amount expended on this work to July 5, 1884, cannot be stated, as it cannot be separated from the sum total of the general expenditures for the work of improving the harbor at Norfolk, Va., and its approaches, of which this was a part up to that date.

The result obtained from the expenditures at this point to November, 1880, was a channel 4,400 feet long, 265 feet wide, and 25 feet deep at mean low water, which greatly facilitated navigation and commerce. This channel has since shoaled to 24 feet in places, and contracted considerably.

No work was done in this locality thereafter until subsequent to the passage of the act of July 5, 1884, which appropriated $50,000 specifically for widening the channel.

There was expended in the fiscal year ending June 30, 1885, $381.36, which was applied to surveying the locality in question and preparing map of same.

A Board of Engineer officers was convened August, 1884, to prepare a project for the application of this appropriation. The Board reported a plan involving, in conjunction with dredging, the construction of a dike at or near Pinner Point, expressing at the same time doubts whether, under the phraseology of the law, any part of the money could be applied to a work of construction.

However, the requirements of navigation demanding the widening of the channel as contemplated in the project already commenced and partly executed, by dredging, it was recommended that the existing appropriation be applied to widening the channel between Lambert's Point and Fort Norfolk by dredging along the eastern side thereof. This having been approved, the work was done accordingly.

There was expended in the fiscal year ending June 30, 1886, $46,806.89, which was applied to the removal of 469,94¼ cubic yards of material, measured in scows, resulting in a straight channel not less than 25 feet deep and at least 400 feet wide, at mean low water, the entire length of this approach. Formerly the channel had an angle in it. This work has materially benefited navigation and commerce. The easterly side of the channel should be buoyed every 1,200 feet to mark it properly.

The amount that can be profitably expended in the fiscal year ending June 30, 1888, is $118,100, which it is proposed to expend in the construction of a dike and in widening the channel along the eastern side by dredging. This will complete the project.

The advantages and benefits to be derived therefrom will be a better approach to the harbor and the navy-yard and more room for anchorage.

July 1, 1885, amount available	$49,618 64
Amount received from sale of fuel to an officer	38 25
	49,656 89
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	46,806 89
July 1, 1886, amount available	2,850 00
Amount appropriated by act approved August 5, 1886	137,500 00
Amount available for fiscal year ending June 30, 1887	140,350 00
Amount (estimated) required for completion of existing project	118,100 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	118,100 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 2.)

3. *Appomattox River, Virginia.*—At the close of the late war the navigation of this river was in such a condition that the depth of water on more than one of the shoals did not exceed 6½ feet at high tide, and this depth was diminished by 3 feet at low tide. The plan of improvement adopted in 1870 was to attain a depth of 12 feet at high tide, with as much width of channel as the river would bear. This plan has been steadily adhered to, constant progress being made towards its completion from year to year by the use of the money granted by Congress. The means depended on have been jetties, wing-dams, and training-walls, with resort to the dredge only when the needs of commerce required immediate work in the channel to give more width or depth than had been attained under the slower operation of the structures mentioned, of which the system has not yet been fully carried out for want

of sufficient funds. The amount expended by the United States up to June 30, 1885, on the project adopted in 1870, is $371,703.95, and resulted in securing a turning basin at Petersburg about 155 by 110 feet and a navigable channel of 12 feet and upwards at high water, with some short shoals, from Petersburg down to Point of Rocks, all of which vastly benefited navigation and largely increased the extensive commerce carried over this river.

There was expended in the fiscal year ending June 30, 1886, the sum of $9,579.79, which was applied to enlarging Puddledock Cut, about 2 miles long. This was materially widened and deepened along the entire westerly side, and also along 1,250 feet of the easterly side, by the removal of 121,424 cubic yards of material, measured in place, including 51,300 cubic yards removed last year. To prevent the dredged material cast on the bank from sliding back into the channel, 940 linear feet of cheap pile and brush revetment was built. This work benefited navigation and commerce. The dikes and training-walls required no repairs to speak of.

There will be but a small balance on hand at the close of the fiscal year ending June 30, 1887. There can be profitably expended in the fiscal year ending June 30, 1888, $27,250, which it is proposed to expend for the completion of the existing project, after which an annual expenditure of $5,000 will be required to maintain the work, as is the case with all works of this class.

The principal portion of the work projected has been done, and, in the main, performs the service required of it.

The condition of permanence of the deepened and improved channel seems to be nearly reached under the influence of its regulation. The truth of this statement is confirmed by the diminished use of the dredge year by year. The best results cannot be said to be reached until its services can be dispensed with under ordinary circumstances.

July 1, 1885, amount available		$10,437 09
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,519 79	
July 1, 1886, outstanding liabilities	60 00	
		9,579 79
July 1, 1886, amount available		857 30
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		19,607 30
Amount (estimated) required for completion of existing project		27,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		27,250 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K 3.)

4. *Nottoway River, Virginia.*—Prior to improvement the condition of this river at low water was as follows: At the mouth the navigable depth was only 2 feet, due to sunken logs; thence to the Seaboard and Roanoke Railroad Bridge, 19 miles, the channel was from 9 to 25 feet deep and much obstructed by a war blockade of sunken vessels, and also by snags, overhanging growth, &c. The next reach, to Peter's Bridge, 31 miles, was so filled with snags, logs, &c., that it was with difficulty that a flat-boat of 1 foot draught could pass over it.

The original project, adopted in 1881, was to obtain a channel not less than 60 feet wide and at least 9 feet deep from the mouth to the railroad bridge, and 2 feet deep thence to Peter's Bridge, by removing the said obstructions.

The amount expended to June 30, 1882, is $6,420.30, which completed the project for the lower 29 miles. There have been no operations since.

This improvement has not led to the development of much trade on the river. There is no regular line of boats there. The river is crossed by the railroad, and for some distance is paralleled, about 5 miles off, by the Blackwater River, on which are lines of steamers.

The small amount, $333.54, expended since June 30, 1882, has been applied to contingencies.

The last examination, made in June, 1885, showed that the portion below the railroad bridge was in fair condition, while that above had again become obstructed by logs, &c., owing to the careless manner in which they had been handled and rafted. For this reason the river is not susceptible of entire and permanent completion.

No further appropriation is asked for this river.

July 1, 1885, amount available	$453 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	207 13
July 1, 1886, amount available	246 16

(See Appendix K 4.)

5. *Blackwater River, Virginia.*—This river originally had a channel, with a minimum depth of 8 feet scant, much obstructed by logs, leaning trees, shoals, projecting points, and a war blockade of sunken vessels, all of which rendered navigation exceedingly difficult.

The original project, adopted in 1878, was to make a channel 9 feet deep and not less than 60 feet wide at ordinary low water, by dredging the bars and points, and removing all the obstructions from its mouth to Franklin, the head of navigation, 13 miles.

There was expended up to June 30, 1884, $14,000. This completed the project except dredging at projecting points, which was only partially done. The work done has materially benefited navigation and commerce.

There were no operaions during the fiscal year ending June 30, 1886, there being no funds available. The last examination, made in June, 1885, showed that the work was generally in good condition, with the exception that two bars previously dredged had shoaled slightly, and several projecting points require more work.

The sum of $2,500 can be profitably expended on this work during the fiscal year ending June 30, 1888. It is proposed to expend this amount in redredging two bars, completing the dredging at three projecting points, and removing a few scattering logs, snags, &c.

This work is not susceptible of entire and permanent completion, and small appropriations will be required from time to time to maintain the channel, which slowly deteriorates.

Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	$2,500 00

(See Appendix K 5.)

6. *Archer's Hope River, Virginia.*—Prior to the commencement of this work there existed a natural channel about 4 feet deep in the river, which could not be reached on account of the bar near its mouth, where it enters the James River.

The original project, adopted in 1881, is to dredge a channel 6 feet deep and not less than 50 feet wide from the mouth to Williamsburg, 5 miles above, where it is crossed by the Chesapeake and Ohio Railroad.

The amount expended to June 30, 1884, is $9,874.79, which resulted in a channel 2,300 feet long, 6 feet deep, and 50 feet wide at mean low water from the mouth up. This did not carry the channel over the bar, which is 700 feet longer. No material benefit to navigation and commerce has yet been realized. There have been no operations since.

The small amount, $104.58, expended since June 30, 1884, has been applied to contingencies. The last examination, made in June, 1885, showed that the outer end of the dredged channel had shoaled about 1 foot, and that the inner part was in good condition.

July 1, 1885, amount available	$45 96
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	25 33
July 1, 1886, amount available	20 63
Amount (estimated) required for completion of existing project	9,400 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix K 6.)

7. *North Landing River, Virginia and North Carolina.*—Originally this river was much obstructed by logs, snags, overhanging growth, &c., and also by shoals and abrupt bends, the least depth being 6½ feet in places.

The original project, adopted in 1879, is to make a channel at low water not less than 9 feet deep and 80 feet wide its entire length—17 miles—by dredging the shoals and bends, and by removing the obstructions.

The amount expended to June 30, 1884, is $49,777.34, and resulted in completing the project, thereby allowing much larger vessels to pass over the river, and increasing the commerce thereon.

The amount expended in the fiscal year ending June 30, 1885, is $4,021.38, $2,082.94 of which was applied to the removal of logs, snags, &c., that had lately entered the river, and the balance to the construction of a combined steam-hoister and pile-driver, pertaining to this and another work.

The amount expended in the fiscal year ending June 30, 1886—$201.28—was applied to the construction of the above machine and to contingencies.

The lower 4¾ miles of the river, from Beacon 1 to Beacon 4, was surveyed in April and May, 1885, and the 9-foot channel therein found to be from 20 to 60 feet in width. No examination has since been made. To restore it to the required width and depth requires the removal of 28,882 cubic yards of material, measured in place, at an estimated cost of $7,220.50.

There will be but a small balance on hand at the close of the fiscal year ending June 30, 1887. There can be profitably expended in the fiscal year ending June 30, 1888, $10,000, which will be applied to redredging some of the shoals and removing logs, snags, &c., that may be encountered.

As this work is not susceptible of entire and permanent completion, no estimate can be made for that purpose. Small expenditures will be required from time to time to maintain it. It has been repeatedly cleared of logs, &c., and this must be expected to continue, unless there be some radical change for the better in the handling of logs that are rafted through it.

July 1, 1885, amount available	$1,701 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	201 28
July 1, 1886, amount available	1,500 00

(See Appendix K 7.)

8. *Edenton Bay, North Carolina.*—The navigable channel through this bay was originally obstructed by an extensive hard sand-shoal, with a depth thereon of 6½ feet.

The project, adopted in 1878 and modified in 1879 and 1885, contemplates making a channel 9 feet deep, 150 feet wide at the outer end and 200 feet wide at the inner end, with a triangular turning-basin midway of about 12 acres, by dredging through the bay to Edenton.

The amount expended thereon up to the close of the fiscal year ending June 30, 1880, is $5,000, and resulted in a channel 100 feet wide and 9 feet in depth, and also the partial construction of the turning-basin, thus materially aiding navigation.

Under the act of August 2, 1882, a survey was made of this locality.

The foregoing comprises all the operations up to July 5, 1884.

The amount expended in the fiscal year ending June 30, 1885, is $11,306.37, and resulted in a channel 9 feet deep at ordinary low water from the 9-foot curve in the bay to Edenton, which channel is 1,100 feet long and 150 feet wide at the outer end, and 1,150 feet long and at least 100 feet wide at the inner end, in front of the Norfolk Southern Railroad Wharf, with the turning-basin midway between nearly completed, all of which has very materially aided navigation and commerce.

The amount expended during the fiscal year ending June 30, 1886, $3,295.22, was applied to enlarging the foregoing channel by the removal of 46,043 cubic yards of material, measured in situ, including 29,000 cubic yards (estimated) removed last year. This makes the channel 150 feet wide at the outer end and 165 feet wide at the inner end, with a triangular turning-basin midway of 9¼ acres. The total area dredged here is 17½ acres and the area 9 feet deep and upwards, at ordinary low water, 18¾ acres. There is a navigable channel of varying width at least 10 feet deep, at same stage, the entire length of the harbor.

The balance of the estimate required for the completion of the adopted project is $6,000, but no appropriation is asked for at present, as Edenton now has a harbor amply sufficient for all the present wants of navigation and commerce, which, so far as can be forecasted, will suffice for some time to come. It is probable that dredging will be required at long intervals, as the bay has a tendency to silt slowly.

July 1, 1885, amount available	$3,742 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,295 22
July 1, 1886, amount available	447 41
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,447 41
Amount (estimated) required for completion of existing project	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 8.)

9. *Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.*—Previous to the commencement of this improvement there was an indifferent natural channel, with a depth of from 5 to 7 feet at low water, which had been partially dredged, in the sound and bay, by the Albemarle and Chesapeake Canal Company.

The original project, adopted in 1878, is to obtain a channel 80 feet wide at bottom and 9 feet deep at ordinary winter water, by dredging the entire length of the sound, 10½ miles, to which was added, in 1880, the project to prolong this channel by dredging through the bay about 2 miles, and to construct a shell dike 9,600 feet along the westerly side of the channel through the latter, to maintain it.

The amount expended to June 30, 1885, is $123,500 and resulted in the construction of the dike, and a channel from 40 to 80 feet wide the entire length and depth projected, all of which greatly improved navigation and increased the commerce over this important inland water-route. There have been no expenditures since.

The entire channel was surveyed last in April and May, 1885, to ascertain its condition, which was found to be quite good, although shoaled in places. This is probably due very largely to steamers grounding out of the channel and creating shoals in their efforts to get off. More buoys maintained constantly between the gas-beacons would tend to diminish this. To restore and complete the work will require the removal of 215,075 cubic yards of material measured in place.

A survey was also made of North River Bar in May, 1885, which can be best and most economically improved by dredging a straight channel through it 7,150 feet long, 150 feet wide, and 9.4 feet deep at ordinary low water. This will require the removal of 37,847 cubic yards of material, measured in place, and the construction of two range-lights (gas beacons) to mark the channel.

The total estimated amount required to do the foregoing dredging is $55,122.85.

Other works have been added to that originally estimated for, making it necessary to increase the estimates accordingly to accomplish all the work contemplated. There will be but a small balance on hand at the close of the fiscal year ending June 30, 1887.

July 1, 1885, amount available	$1,500 00
July 1, 1886, amount available	1,500 00
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	11,500 00
Amount (estimated) required for completion of existing project	55,122 85
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 9.)

10. *Meherrin River, North Carolina.*—Previous to the commencement of operations on this improvement the channel was so much obstructed by logs, snags, leaning trees, &c., as to make navigation difficult and and dangerous. There were also some shoals, having a ruling depth of less than 8 feet.

The original project, adopted in 1883, for the improvement of this river from its mouth to Murfreesboro', the head of navigation, 11 miles, confined operations to the removal of logs, &c., the appropriation not being sufficient to undertake dredging in addition.

The amount expended to June 30, 1884, was $4,133.90, which resulted in doing all the work projected except dredging, and giving a channel having a depth of 9 feet save at a few places.

In the fiscal year ending June 30, 1885, there was expended $418.50, which resulted in again clearing the river of all obstructions like the aforesaid. The last examination, made in June, 1885, showed that the river was in fair navigable condition.

The amount expended in the fiscal year ending June 30, 1886, $32.13, was applied to contingencies.

The amount that can be profitably expended in the fiscal year ending June 30, 1888, is $7,500, with which it is expected to still further aid navigation and commerce by dredging shoals and removing obstructions as they form. This is expected to complete the improvement as estimated, securing a channel 9 feet deep and 60 feet wide at low water. Small appropriations will be required from time to time in order to maintain the work, as it is not susceptible of entire and permanent completion, being a log-bearing stream.

July 1, 1885, amount available	$447 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	32 13
July 1, 1886, amount available	415 47
Amount (estimated) required for completion of existing project	7,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 10.)

11. *Pamplico and Tar rivers, North Carolina.*—The Pamplico River was originally obstructed by a war blockade of piling near Hill's Point, and also by stumps and shoals just below Washington. The Tar River was likewise obstructed by a war blockade of piling near Washington, and also by shoals, snags, &c., further up, which made navigation difficult and uncertain.

The original projects for the improvement of these rivers contemplated removing these obstructions, and also widening, deepening, and straightening the channel of the Pamplico River below Washington, by dredging.

Previous to the act of June 14, 1880, the appropriations for them were distinct and separate. Since then they have been consolidated in one appropriation.

The amount expended to June 30, 1885, is $50,537.10, and resulted in a channel 9 feet deep at low water, and from 108 to 175 feet wide, from the deep water of Pamplico River to Washington, 1½ miles. Nothing further is desired except to widen the channel, which it is not proposed to do at present.

On the Tar the work resulted in a navigable channel 3 feet deep at low water, from Washington to Greenville, 23 miles, the year round, and thence to Tarboro', 26 miles, only during high water.

The amount expended in the fiscal year ending June 30, 1886, is $2,414.23, which was all expended on the Tar River and applied to the construction of a combined steam-hoister and pile-driver for this and another work, and the removal and destruction of 683 obstructions between Washington and Greenville, thereby effecting an improvement greatly desired.

There will be but a small balance on hand at the close of the fiscal year ending June 30, 1887. The amount that can be profitably expended during the fiscal year ending June 30, 1888, is $5,000. It is proposed to apply this to continuing the improvement by removing snags, shoals, overhanging growth, &c., and the repair and construction of jetties, for the furtherance of navigation and commerce.

The work of improvement contemplated in the original estimates upon the Tar River is complete, but more work is needed. It is not susceptible of entire and permanent completion, as the jetties require repairs, and logs, snags, &c., are constantly appearing. A continuance of its best possible condition requires an annual expenditure of $5,000 to maintain it.

July 1, 1885, amount available	$2,462 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,414 23
July 1, 1886, amount available	48 67
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,048 67
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867	5,000 00

(See Appendix K 11.)

12. *Yadkin River, North Carolina.*—Previous to the commencement of this improvement, in the fall of 1880, there was no navigable channel whatever, as the river was obstructed by numerous shoals, rock ledges, and mill-dams. The original project of 1879, adopted in 1880, was to improve the portion of the river from the North Carolina Railroad Bridge near Salisbury up to the foot of Bean Shoals, 64½ miles, over which it was proposed to obtain a low-water channel the entire year from 2½ to 3 feet in depth and of ample width for the trade seeking it. To accomplish this the project was to blast and remove the rock, construct jetties, and take out the mill-dams. No locks were contemplated.

The act of July 5, 1884, provides: "That the sum of $6,000 authorized by the act approved June 14, 1880, to be expended for the removal of dams in Yadkin River, North Carolina, may be used by the Secretary of War for acquiring the right of way by removal or otherwise of such dams as may be necessary for the contemplated improvement, the said right of way or removal to be obtained by agreement with the parties interested, or in event of failure, to make a reasonable agreement by condemnation, as provided for by the laws of the State of North Carolina."

It is questionable whether any of this will be necessary, as recent investigations of the local engineer show that the dams can all be best and most economically passed by wing-dams and training-walls, or by locks, as the case may be. Accordingly, this amount will be held for the present, and the balance of the funds available will be devoted to securing a navigable channel at least 2½ feet deep and 60 feet wide at winter stage only from the North Carolina Railroad Bridge to Hartley's Mill-dam, 28 miles, by the construction of wing-dams and training-walls, and the removal of rock ledges.

It would be very expensive to make low-water navigation on this river in any manner; the commerce to be developed would not justify it. Locks must be resorted to from Douthet's Mill-dam up, in order to pass most of the mill-dams. Below this point none are required.

Up to June 30, 1885, there was expended $62,276.05, which resulted in securing an indifferent channel from 40 to 70 feet wide, and from 2 to 2¼ feet deep for eight months of the year, the season of "winter water," from the North Carolina Railroad Bridge to Swicegood's Mill-dam, 21½ miles; at the lowest stage there is no continuous navigable channel, it being but 9 inches deep at one point, Boone's Ford.

In the fiscal year ending June 30, 1886, there was expended $6,339.85, which completed the channel at winter stage around Swicegood's Mill-dam by the construction of 361 linear feet of wing-dams, two sill-dams 60 linear feet each, and 125 linear feet of training-wall, the raising of 498 linear feet of wing-dams, and 150 linear feet of training-wall above low water, and the removal of rock ledges.

It is proposed to expend the available funds in lengthening and further improving the channel at winter stage. The advantages and benefits to be expected therefrom will be to create a navigable channel for which there are no commercial boats on this river, and but little prospect of any.

The estimated amount required for the entire and permanent completion of the work of improvement in accordance with the approved and adopted project is largely in excess of the estimate, $81,674.85, originally submitted (see page 627, Report of the Chief of Engineers, 1879), the sum of $77,000 having already been appropriated and $68,615.90 spent to June 30, 1886, and only 21½ miles (one-third the distance) partially improved, and this for only navigation at winter stage. The most difficult and expensive portion yet remains to be improved, even for navigation at winter stage. Of course, for navigation at low water, as projected, the expense would be much greater.

July 1, 1885, amount available	$14,723 95
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,339 85
July 1, 1886, amount available	8,384 10
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	18,384 10

(See Appendix K 12.)

13. *Scuppernong River, North Carolina.*—Before work was commenced on this river there was a bar at the mouth with about 5 feet of water thereon. The upper portion of the river was obstructed by logs, snags, stumps, overhanging growth, and projecting points at abrupt bends, permitting navigation for small vessels only, and with difficulty.

The original project, adopted in 1876, was to dredge the bar and make cut-offs at the projecting points, and also to remove the said obstructions to obtain a channel at low water 9 feet deep and 60 feet wide from its mouth to Spruill's Bridge, the head of navigation, 22 miles.

The amount expended to June 30, 1883, was $6,000, and resulted in completing the greater portion of what was projected, to the great benefit of navigation and commerce. There have been no funds available since, until the passage of the act of July 5, 1884, which appropriated $2,000 for this work. The amount expended in the fiscal year ending June 30, 1885, was $120.67, which was applied to an examination of the river and the purchase of dynamite, &c., preliminary to the resumption of operations.

In the fiscal year ending June 30, 1886, there was expended the balance of the appropriation, $1,879.33, which resulted in making one cut-off, widening another and the thoroughfare, cutting off eight projecting points at abrupt ends, enlarging the turning-basin at the head of navigation (Spruills's Bridge), and removing a shoal 650 feet long at the mouth of Collins's Canal. This work has practically completed the improvement, which has shortened the distance about half a mile, saved almost endless trouble and lessened danger in the management of steamers, permitted larger loads to be carried, &c.

It is believed that the channel is amply sufficient for the trade seeking it, and that it will be quite permanent, as this river is not subject to freshets of any magnitude. However, a shoal may re-form slowly at Collins's Canal.

No further funds are asked for.

July 1, 1885, amount available	$1,879 33
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,879 33

(See Appendix K 13.)

14. *Removing sunken vessels or craft obstructing or endangering navigation.*—1. *The schooner Lawrence.*—This wreck, referred to in last annual report, was sunk in the Scuppernong River, North Carolina, and was removed by the Government, after due advertisement, as the owner did not do so, at a cost of $100.

2. *The barge Albemarle.*—This wreck was reported an obstruction to navigation on the coast, off Hog Island light-house, Virginia. An examination was made of the same, without cost to the Government, which showed that it had ceased to be such an obstruction.

3. *The schooner Maria and Elizabeth.*—This wreck, which is sunk off Cape Charles light-house, Virginia, was reported an obstruction to navigation. An examination was made of the same, without expense to the United States, which showed that it had ceased to be such an obstruction.

4. *The schooner Tarry Not.*—This wreck was reported an obstruction to navigation on Craney Island Flats, near the mouth of the Nansemond River, Virginia. An examination verified the report. After due advertisement, the wreck and cargo, being worthless, were destroyed by explosives, at a cost of $428.43.

5. *The schooner Anthea Godfrey.*—This wreck, sunk in Lynn Haven Roads, Virginia, was reported an obstruction to navigation. An examination showed such to be the case, and, after due notice, the wreck and cargo, being valueless, were removed by explosives, at a cost of $387,37.

6. *The steamer Concord.*—This steamer was burnt and sunk in the Pamplico River, near Washington, N. C., on February 20, last. An examination thereof was made, which showed that she endangered navigation. After due notice, she was libeled in the United States District Court, and advertised to be sold on July 2, 1886. There will, therefore, be no further operations in this matter until the Court has finally disposed of her, and the purchaser, if any, has had reasonable time to act. Her machinery has some value, but the hull and cargo (principally cotton) have but little, if any.

All the foregoing work was done by hired labor, the purchase of material in open market, and the use of the Government plant, that being the most economical and advantageous mode of doing it. It is proposed to remove the wreck of the Concord in a similar manner, if it has to be done by the Government; the estimated cost being $500.

(See Appendix K 14.)

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS OF NORTH CAROLINA AND SOUTH CAROLINA.

Officer in charge, Capt. W. H. Bixby, Corps of Engineers; Supervising Engineer, Lieut. Col. W. P. Craighill, Corps of Engineers.

1. *Contentnea Creek, North Carolina.*—This stream, a tributary of the Neuse River, has a total length of about 144 miles and a drainage area of 1,184 square miles. Prior to Governmental improvement in 1881, it had a depth of about 3 feet during 9 months of the year, from its mouth in the Neuse River upward about 63 miles to Stantonsburg, its practical limit of navigation; but its channel was completely blocked at all stages of water by sunken logs and stumps, and by floating obstructions. Its steamboat commerce was nothing.

The original project of 1881, as continued to date, proposed to secure a safe and unobstructed 3-foot navigation over this entire distance during the high-water season of about nine months.

During the last fiscal year ending June 30, 1886, $1,419.08 was spent in diking the river bank near its mouth to prevent the water running off into the adjacent swamps, and in removing dangerous obstructions in the river channel below Snow Hill. Further work was stopped by want of funds.

Up to June 30, 1886, therefore, a total of $24,637.69 has been spent in all upon this improvement in securing a roughly cleared 3-foot navigation over the 31 miles from its mouth up to Snow Hill, during the high-water season. In consequence of this, a steamboat line has been permanently established upon the whole length thus improved, and two steamboats have made biweekly trips during nearly nine months each year, to the great benefit of the neighboring country, otherwise without transportation facilities for its products. The present commerce (including rafted goods) is rapidly increasing, and is at present about $450,000 per year; showing that each dollar spent on this improvement has been accompanied by the development of $18 in annual commerce.

There are three county bridges, without draws, above Snow Hill; their obstruction is not serious at present.

The officer in charge recommends that this improvement be completed in accordance with the present proposed and approved project, so as to secure a thoroughly cleared 3-foot navigation over the entire river from its mouth 63 miles upward to Stantonsburg during the nine commercial busy months of the year; at a total expense of $35,000 in addition to the amount available for the fiscal year ending June 30, 1887, this amount to be appropriated in one sum. Smaller appropriations will increase the cost.

Further improvement, so as to extend this navigation above Stantonsburg, or so as to make the lower river navigable during the low-water season, is not recommended at present.

After the improvement is finished, its proper maintenance may cost from $1,000 to $3,000 per year.

It is estimated that $30,000 can be profitably spent in a single year; 20,000 of this to secure a fairly cleared natural channel for steam navigation nine months of the year from Snow Hill 32 miles upward to Stantonsburg, by removing from the river channel the most dangerous obstructions, such as sunken logs and snags, and by cutting down and pulling back from the banks the most troublesome leaning trees, and also those which would otherwise soon fall into the river channel; and $10,000 to dike and dredge the natural channel near the river's mouth so as to keep the water from running off into the adjacent swamps. The extension of the navigation to Stantonsburg will open up the richest part of the Contentnea Basin and will greatly increase the river commerce.

July 1, 1885, amount available		$1,731 39
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,398 67	
July 1, 1886, outstanding liabilities	20 41	
		1,419 08
July 1, 1886, amount available		312 31
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		15,312 31
Amount (estimated) required for completion of existing project		35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 1.)

2. *Trent River, North Carolina.*—This river, a tributary of the Neuse River, has a total length of about 73 miles, and a drainage area of 657

square miles. In 1879, at the time when placed under Governmental improvement, it possessed a 6-foot to 8-foot roughly cleared navigation from its mouth at New Berne up 21 miles to Pollocksville, and a lighter draught navigation 9 miles further to Quaker Bridge. Above Pollocksville the bars, snags, and trees prevented all navigation, except occasionally by small flat-boats during high freshets. Its commerce is estimated to have been about $400,000 of goods per year.

The original projects of 1879 and 1880, as continued to date, assumed that 6 to 8 feet of water could be carried at all stages of water from its mouth 21 miles to Pollocksville, and proposed to secure a thoroughly cleared 3-foot navigation, with at least 50 feet channel width, at all stages of water, from Pollocksville 22 miles up to Trenton, the practicable limit of steamboat navigation, using the balance of the funds to improve the channel from its mouth 30 miles upward to Pollocksville and Quaker Bridge.

During the last fiscal year, ending June 30, 1886, while awaiting further appropriations, $159.50 was spent in caring for the property and records, and in preparing reports and future projects.

Up to June 30, 1886, therefore, a total of $41,489.06 has been spent in ll upon this improvement, in securing a moderately well cleared 6-foot o 8-foot navigation at all stages (8 to 9 feet at ordinary stages) from New Berne 30 miles up to Quaker Bridge, and thence a thoroughly cleared 3-foot navigation, at least 50 feet wide at all stages, 13 miles further to Trenton, and an excellent turning-basin at Trenton. In consequence of this improvement a steamboat navigation has been permanently established over the entire river to Trenton, with weekly trips n summer and tri-weekly trips in the busy season of winter. The commerce is still increasing, and is now about $600,000 (including rafted goods) of transported goods per year, showing that each dollar spent n this improvement has been accompanied by the development of about 5 of annual commerce.

The river navigation is not obstructed by bridges without draws.

The officer in charge recommends that the present approved and dopted project be completed by thoroughly clearing the present chanel of its remaining obstructions, at a total cost of $11,000, in addition the amount available for the year ending June 30, 1887, this amount be appropriated in one sum within the next year. Smaller appropriations will increase the cost.

After this is done no further improvement is recommended at present; but the proper maintenance of the improved channel may cost from 1,000 to $2,000 per year.

It is estimated that the entire $11,000 can be profitably spent in one ear—$8,000 to cut off projecting points at sharp turns of the river, and he remaining $3,000 to clear the entire river thoroughly of all remaing obstructions to its free navigation.

ly 1, 1885, amount available		$670 44
ril 23, 1886, amount received from sales to Contentnea Creek		25 00
		695 44
ly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$158 78	
ly 1, 1886, outstanding liabilities	72	
		159 50
ly 1, 1886, amount available		535 94
mount appropriated by act approved August 5, 1886		3,500 00
mount available for fiscal year ending June 30, 1887		4,035 94

Amount (estimated) required for completion of existing project........ $11,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 11,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 2.)

3. *Neuse River, North Carolina.*—This river, emptying into Pamplico Sound, has a total length of about 360 miles, and a drainage area of 5,781 square miles (2,506 of which are situated above the mouth of its upper main tributary, the Contentnea). This river, when placed under Governmental improvement in 1878, possessed during nine months of the year a 9-foot depth of channel from its mouth 40 miles up to New Berne; thence a 4-foot depth 50 miles further to Kinston; thence a 3-foot depth 46 miles further to Goldsboro'; and thence a 2-foot depth 62 miles further to Smithfield, this depth being reduced during the low-water season to 8 feet at New Berne, 2 feet at Kinston, and 1 foot at Smithfield. Over the whole 198 miles the river was so blocked by artificial and natural obstructions that navigation was impracticable. Its steamboat navigation was therefore nothing.

The projects of 1878, 1880, and 1883, as continued to date, proposed to clear out the obstructions placed in the river during the war of 1861-'65, to remove all sunken logs, snags, and floating obstructions, and to contract the channel-way, so as to assure during the entire year an unobstructed 8-foot navigation 40 miles up to New Berne, and a similar 4-foot navigation 50 miles further to Kinston, and during nine months of the year a 3-foot navigation 108 miles farther to Smithfield.

During the last fiscal year ending June 30, 1886, $9,557.42 was spent in contracting by jetties about 2 miles length of river channel between New Berne and Kinston, in removing the most troublesome obstructions in this same length of river, in caring for property and records, and in preparing reports and future projects.

Up to June 30, 1886, therefore, a total of $205,825.72 has been spent in all upon this improvement, giving a moderately well-cleared channel over the entire length of the river, allowing an 8-foot navigation 40 miles to New Berne, and a 2-foot navigation 50 miles further to Kinston all the year; also a 3-foot navigation 46 miles further to Goldsboro' during nine months per year, and 60 miles still further to Smithfield six months per year. In consequence of this two steamboat lines have been permanently established between New Berne and Kinston, and the river commerce has increased from almost nothing up to over $1,000,000 per year, showing that each dollar spent upon this improvement has been accompanied by a development of about $5 of annual commerce.

The Atlantic and North Carolina Railroad Drawbridge at Kinston has a draw, but not over the main channel-way; its obstruction is not serious at present. The Wilmington and Weldon Railroad Bridge at Goldsboro' is without a draw, but 17 feet above low water; its obstruction is not serious at present. Higher there are six county bridges without draws; their obstruction is not serious at present.

The officer in charge recommends that this improvement be completed in accordance with the present approved and adopted projects, so as to secure a thoroughly cleared 9-foot navigation 40 miles up to New Berne and a similar 4-foot navigation 50 miles further to Kinston during the entire year; and thence a similar 3-foot navigation 108 miles further to Smithfield during nine months of the year; at a total expense of $137,500, in addition to the amount available for the fiscal year ending June 30, 1887, this amount to be appropriated in three yearly installments of $46,000 each; smaller appropriations will increase the cost. Further improvement, so as to extend the navigation above Smithfield, or so as to increase the depth of water or length of time of such navigation below Smithfield, is not recommended at present. After the improvement is finished its proper maintenance may cost from $2,000 to $6,000 per year.

It is estimated that the first installment can be profitably spent in a single year, $30,000 of which is to secure an unobstructed channel of 3 feet depth at low water from New Berne 50 miles upward to Kinston, by completing the present work of contraction of the river channel, and $16,000 towards securing a thoroughly-cleared, natural channel from Kinston, 108 miles upward to Smithfield, by removing from the river channel sunken logs and snags, and by cutting down and pulling back from the banks such trees as overhang the channel, or as might fall into the channel by the caving of banks. The works have given satisfactory results so far as their construction has been carried, but they cannot produce their effect upon the river commerce until they are finished over the entire distance thus to be improved.

July 1, 1885, amount available		$13,731 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,166 05	
July 1, 1886, outstanding liabilities	391 37	
		9,557 42
July 1, 1886, amount available		4,174 28
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		26,674 28
Amount (estimated) required for completion of existing project		137,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		46,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 3.)

4. *Inland line of navigation, from New Berne to Beaufort, North Carolina.*—The inland line of navigation from New Berne to Beaufort Harbor, *via* Clubfoot, Harlowe and Newport rivers, established in about 1826, follows the course of the line now in reconstruction by the New Berne and Beaufort Canal Company. This inland line of navigation, by the way of Clubfoot, Harlowe, and Newport rivers, was recommended in 1883 as conditionally worthy of improvement; and was estimated in 1883 to cost $883,580. This line of navigation possessed then no steamers, but one has since been placed upon the route, and is now making regular trips. This line of navigation is of much value as a connecting link between Pamplico Sound and Beaufort Harbor, and completes existing inland navigation from the Chesapeake to Beaufort, N. C.

Ten thousand dollars was appropriated in 1882 ($5,000 to be taken from the appropriation for Neuse River, $5,000 from that for Beaufort Harbor) for an inland line of navigation from New Berne to Beaufort Harbor; and it was decided in 1884 that this money was to spent upon the route *via* Clubfoot, Harlowe, and Newport rivers. The adopted project of 1884 for the expenditure of this $10,000, as continued to date, proposed to widen and deepen Harlowe Creek so as to secure a through canal, of 5 feet depth at mean low water and of 30 feet bottom width, from the mouth of Harlowe Creek upward 3.25 miles to its head; and to use the remaining funds in similar work upon Clubfoot River.

During the last fiscal year ending June 30, 1886, while awaiting the further action of Congress, $131.45 was spent in inspecting the canal and creeks, in caring for property and records, and in preparing reports and future projects.

Up to June 30, 1886, therefore, a total of $2,205.76 has been spent in all on necessary surveys and in commencing the proposed canal cutting. It was required that the work should be done at once, and by contract. Work was commenced, but on account of unexpected obstacles and the small amount of available funds, the contractor could not afford to build or hire the expensive plant that he would need in order to fulfill his contract. Beneficial results have therefore not been as yet obtained. Work was directed to be stopped March, 1885, to await further action of Congress.

The officer in charge recommends that this improvement be extended in general accord with the projects of 1883 and 1884, over the whole distance through the New Berne and Beaufort Canal, as well as through Clubfoot River and Harlowe Creek, so far as to secure a through channel of 5 feet depth at mean low water, and 30 feet bottom width, from the mouth of Harlowe Creek to the mouth of Clubfoot River, thus completing a 5-foot navigation from New Berne to Beaufort, at a total expense of $75,000, in addition to the $17,794.24 available for the fiscal year ending June 30, 1887, this amount to be appropriated in two yearly installments. Smaller appropriations will increase the cost. The dangers of ocean travel around Cape Hatteras and Cape Lookout are so great that some such 5-foot navigation for small vessels appears necessary between Pamplico Sound and Beaufort Harbor, and no similar navigation can be secured by any other route, except at greatly increased expense. Further improvement over this route, so as to secure a channel of more than 5 feet depth at low water, is not recommended for the present.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1885, amount available		$7,925 69
July 1, 1866, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1 97	
July 1, 1886, outstanding liabilities	129 48	
		131 45
July 1, 1886, amount available		7,794 24
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		17,794 24
Amount (estimated) required for completion of existing project		75,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		38,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 4.)

5. *Harbor at Beaufort, North Carolina.*—This harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only one of any importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles. It is especially valuable as the natural outlet to the inland commerce of Northern and Middle North Carolina, and as the natural harbor of refuge to vessels overtaken on this most exposed portion of the Atlantic coast. If its channel were marked by range lights, it would be the easiest harbor to enter between the Chesapeake and Savannah. Beaufort Harbor, before improvement in 1880, possessed a bar entrance of 15.3 feet least depth at mean low water, with an average rise and fall of tide of 3 feet. From the bar it possessed a channel of 25 feet depth upward, 3.7 miles to the Atlantic and

orth Carolina Railroad Wharf at Morehead City, and a branch channel f 9 feet deep for six-tenths of a mile up to Bulkhead Channel, and of feet minimum depth six-tenths of a mile to the wharves of Beaufort ity, where coasting vessels had a good wharfage of 7 feet depth and ,800 feet long.

The projects of 1881, 1882, and 1884, as continued to date, proposed secure this harbor, by stopping further erosion of the sand-banks at hackleford Point and Fort Macon Point, which limit the width of the arbor entrance, and which had been worn away 500 feet between the ears 1864 and 1880, and 900 more between the years 1880 and 1881, nd by stopping further deterioration of the bar entrance, which was apidly shoaling; and they also proposed afterward to extend the 9-foot epth of water from Bulkhead Channel to Beaufort City, by a cutting 0 feet wide, and thence to dredge a 6-foot channel 100 feet wide to orth River and Core Sound for the accommodation of the small craft the neighboring sound.

During the last fiscal year ending June 30, 1886, $2,218.56 was spent strengthening existing jetties at Shackleford Point, in commencing new jetty at Fort Macon Point, in rebuilding a small landing wharf, nd in completing a survey of the harbor. Further much needed work as stopped for want of funds.

Up to June 30, 1886, therefore, a total of $75,000 has been spent in all pon this improvement in successfully stopping the erosion of Shackle-rd Point and Fort Macon Point, in probably arresting the shoaling pon this bar, and in making a careful survey of the present condition the harbor entrance preparatory to the definite location of further orks. No improvement of commerce nor depth of water was thereby pected nor obtained, but the retrograde movement has been in gen-al arrested, and the old shore line has commenced to reform.

The officer in charge recommends that the present approved projects completed so far as to thoroughly protect Shackleford and Fort Ma-n from further erosion, and to dredge a reduced channel of 100 feet dth and 5 feet depth at low water from Bulkhead Channel entirely rough to Beaufort City, at an expense of $69,000 in addition to the nds available for the fiscal year ending June 30, 1887; this amount be appropriated in one sum during the next year. Smaller appro-iations will increase the cost. Further improvement in accord with original project, so as to secure to Beaufort City a channel of over eet depth at low water from Bulkhead Channel, or of any depth by y other route to North River and Core Sound, is not recommended at esent. This improvement once thoroughly completed should be per-nent.

y 1, 1885, amount available	$2,218 56
y 1, 1886, amount expended during fiscal year, exclusive of liabilities utstanding July 1, 1885	2,218 56
ount appropriated by act approved August 5, 1886	15,000 00
mount (estimated) required for completion of existing project	69,000 00
mount that can be profitably expended in fiscal year ending June 30, 1888	69,000 00
bmitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

See Appendix L 5.)

. *New River, North Carolina.*—This river, emptying directly into the antic Ocean between Beaufort Harbor and Wilmington, N. C., has otal length of about 52 miles and a drainage area of 492 square es. Its lower 14 miles, from its mouth to Jacksonsville, forms a fine in of brackish water of from 500 to 10,000 feet width and of at least

5 feet channel depth, with 40,000 acres of oyster farms and with rich agricultural surroundings. When placed under Governmental improvement in 1882 it had very poor facilities for transporting its goods to market. Its communication with the ocean was blocked by an oyster-rock barricade, through which there existed only a long and very crooked channel of 50 feet width and 3 feet depth at low water. Its commerce, limited to wagons and small boats, was estimated to be about $400,000 of goods per year.

The original project, as continued to date, proposed to secure a 150-foot channel, 5 feet deep at low water, from the upper river to the ocean by dredging.

No money had been spent upon this work prior to June, 1885, because the available funds were too small for profitable use under the existing project.

During the last year ending June 30, 1886, $9,810.24 was spent in making a new survey and project; in newly locating the line of proposed channel and in excavating 34,991 cubic yards of material, thereby replacing the long and crooked channel by a shorter and straight channel of 40 feet bottom width and 3.5 feet least depth at low water. Further work was stopped for want of funds.

The officer in charge recommends that the present adopted project be completed so as to secure a channel of from 100 to 150 feet width and 5 feet depth at low water, from the ocean up to the upper river, at a total expense of $20,000, in addition to the amount available for the fiscal year ending June 30, 1887, to be appropriated in a single amount within the next year. Smaller appropriations will increase the cost. Further improvement, so as to give a channel of greater depth or width, is not recommended at present. This improvement, once thoroughly completed, should be permanent.

He also estimates that $30,000 can be profitably spent in a single year in completing and extending the above channel of 40 feet width, and in increasing its dimensions to 100 feet width and 5 feet depth at low water.

July 1, 1885, amount available		$10,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,152 04	
July 1, 1886, outstanding liabilities	658 20	
		9,810 24
July 1, 1886, amount available		189 76
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		10,189 76
Amount (estimated) required for completion of existing project		20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 6.)

7. *Cape Fear River, above Wilmington, North Carolina.*—The Cape Fear River, above Wilmington, has a total length of about 400 miles, and a drainage area of 7,167 square miles, of which 5,620 square miles lie above the mouth of its main tributary, the Black River. Before improvement in 1881, it was navigable during the nine flush-water months of the year from Wilmington 112 miles upward to Fayettville, but the channel for the upper 75 miles was badly obstructed by sunken logs, snags, overhanging trees, and shoals; and for the upper 66 miles was full of shoals, on which there was not more than 12 to 14 inches of water during the low-water season. At that time the navigation was owned

by private parties. Its commerce was estimated to have been about $800,000 of transported goods per year.

The original project of 1881–'82, as continued to date, proposed to buy out the private owners of the river for $10,000, then to clear out its natural obstructions, and to further provide a continuous channel over its upper 66 miles by dredging and by artificially contracting its waterway through 32 shoals at least.

During the last fiscal year, ending June 30, 1886, $5,516.98 was spent in contracting the river channel by jetties at 4 shoals between Fayetteville and Elizabethtown, in removing the most troublesome obstructions in this same length of river, in completing maps, in gauging the river at several points, and establishing its longitudinal slope at dead low water, in repairs of plant and care of property. Further work was stopped by want of funds.

Up to June 30, 1886, a total of $64,530.81 has been spent in all upon this improvement, giving a moderately well cleared channel over the whole length of river; a moderately good continuous 4-foot channel during the entire year from Wilmington 44 miles to Kelley's Cove; thence a similar 2-foot channel 26 miles further to Elizabethtown (a place of considerable commerce); and thence a similar 1-foot channel 42 miles further to Fayettville, increased to 5-feet draught from Wilmington to Fayettville during seven months per year. In consequence, three permanently established steamboat lines have been running over the entire distance with full draught for seven months each year, and with lessened draught the rest of the time. The commerce during those years has increased about $200,000 per year, showing that each dollar spent upon this improvement has been accompanied by the development of about $28 of annual commerce.

It is recommended that improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 4-foot channel from Wilmington 70 miles to Elizabethtown; thence a similar 3-foot channel 42 miles further to Fayettville during 11 or 12 months of the year; at a total expense of about $200,000, to be appropriated in yearly installments of about $30,000, as smaller appropriations will increase the cost.

The first installment can be profitably spent in a single year; to increase the depth of water at the worst shoals by contracting the river channel by jetties; and in removing from the river channel the most troublesome sunken logs and snags and to cut down and pull back from the river banks the most troublesome leaning trees, as also such as might soon fall into the river channel.

After the improvement is completed it may cost from $1,000 to $3,000 for its proper maintenance per year.

July 1, 1885, amount available		$5,986 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,480 74	
July 1, 1886, outstanding liabilities	36 74	
		5,516 98
July 1, 1886, amount available		469 19
Amount appropriated by act approved August 5, 1886		11,250 00
Amount available for fiscal year ending June 30, 1887		11,719 19
Amount (estimated) required for completion of existing project		200,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 7.)

8. *Cape Fear River below Wilmington, North Carolina.*—This river, emptying into the Atlantic Ocean at Cape Fear, has from its mouth up to its headwaters in the mountains a total length of about 426 miles, and a drainage area of 9,115 square miles. The two main branches of the river meet at Wilmington, bringing with them an average fresh-water discharge of 14,000 cubic feet per second. Below Wilmington the river is a tidal basin with about 26 miles length, 350 square miles drainage area, 37 square miles water surface, 3.5 feet rise of tide (2.5 at Wilmington, 4.5 at the ocean), and an average discharge during ebb of 160,000 cubic feet per second, the ocean bar being 2 miles seaward of the river mouth. The Cape Fear River, below Wilmington, before improvement in 1829, had three bar entrances with least depths as follows: About 9 feet at the Baldhead Channel, 9 feet at the Rip Channel, and 10 feet at New Inlet Channel, these bars being, respectively, 9, 6, and 2 miles below the point which was then the head of the river's delta. From the head of this delta 20 miles up to Wilmington there were several shoals with a least depth of 7.5 feet at low water.

The original project of 1827 to 1847 proposed to improve the upper 20 miles by dredging and by jetty contraction of the channel.

During this time, $203,204.59 were spent in increasing the depth upon the shoals to 9.5 feet at low water, equal to that at the bar entrance.

At or about this time, the shore at Fort Caswell, opposite Baldhead Point, was protected by stone jetties.

The projects of 1852 to 1857 proposed to deepen the water at the main entrance by jetties at Baldhead Point, and by jetty and dike obstructions between Zeke's Island and Smith's Island, near New Inlet, and suggested the possible future necessity of closing New Inlet. During this time $156,296.26 were spent upon these works, which, never fully completed for want of funds, were moreover nearly destroyed later by the heavy storms of 1857 and 1871. The project of 1870 proposed a crib closure of the space (4,403 feet long) between Smith's and Zeke's islands (finished in 1873), to prevent further widening of New Inlet. The projects of 1870 to 1872 for the proposed complete closure of New Inlet (begun in 1875 and finished in 1881), in order to deepen the water at the main (Baldhead) bar entrance. The projects of 1872 to 1883, as continued to date, proposed the extension of the New Inlet dam 2 miles further down the stream to prevent the further erosion of Smith's Island at the swashes. The project of 1875, as continued to date, proposed the occasional use of dredging upon the outer bar to assist the tidal currents in gradually localizing, straightening, deepening, and fixing the bar entrances. The projects of 1874 to 1881 for the 20 miles above New Inlet, as continued to date, proposed dredging wherever necessary across shoals, so as to secure first a 12-foot channel, 200 feet wide, and then a 16 foot channel, 270 feet wide, at low water over this whole length.

During the last fiscal year ending June 30, 1886, $66,052.81 was spent in opening a continuous channel of at least 111 feet width and 16 feet depth at low water from Wilmington to the ocean bar, in making these channels by guide-piles and range-targets, in completing the extension of the New Inlet dam from Zeke's Island southward to Smith's Island, and in raising this extension to mean tide-level, in necessary surveys and in the care of property. Further work was stopped for want of funds.

Up to June 30, 1886, therefore, a total of $1,698,411.74 has been spent in all upon the proposed improvement of 1870 to 1882 with great success, obtaining a 13.5 to 14-foot least depth of water at the main bar entrance, and completing to partial width the desired 16-foot channel 23 miles further to Wilmington. This depth, combined with the average rise of tide (4.5 at the bar and 2.5 at Wilmington), is such that at present vessels loaded to 16 feet draught can readily go from Wilmington to the ocean in a single tide any day of the year. The total commerce, exports and imports, foreign and coastwise, has increased from about $13,000,000 of transported goods in 1870 up to about $17,000,000 in 1886 (all this increase being foreign commerce), showing that each dollar spent upon this improvement has already been accompanied by the development of about $2.40 of annual (foreign) commerce, although the last increase of 2 feet in draught in the river channel is too recent to have produced its effect on such development.

The officer in charge recommends that the above improvements be carried as originally projected by completing the unfinished dike south of Zeke's Island, so as to thoroughly secure Smith's Island from further erosion by the ocean; and by widening and deepening the existing river channels to their full dimensions of 270 feet width and 16 feet least depth at low water, and by further protecting them against further subsequent deterioration by submerged stone dikes where necessary, and by straightening, deepening, and fixing the bar entrance, at a total expense of $245,000 in addition to the amount available for the fiscal year ending June 30, 1887, to be appropriated in one sum during the next fiscal year. Smaller appropriations will increase the cost. So far as can be seen at present, this amount will complete all existing projects for this improvement.

After this improvement is finished, its proper maintenance may cost from $5,000 to $15,000 per year for a few years, but the improvement should be fairly permanent.

It is estimated that the entire sum can be profitably spent in a single year, in repairs of plant, in the completion of dikes, and in the completion of dredging, so as to secure a channel of 270 feet width and 16 feet depth at low water, from Wilmington 29 miles to the ocean bar, and 14 feet depth at low water over the bar.

July 1, 1885, amount available		$70,141 07
July 15, 1885, amount received from sales to Beaufort Harbor		720 00
		70,861 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$65,124 33	
July 1, 1886, outstanding liabilities	928 48	
		66,052 81
July 1, 1886, amount available		4,808 26
Amount appropriated by act approved August 5, 1886		157,500 00
Amount available for fiscal year ending June 30, 1887		162,308 26
Amount (estimated) required for completion of existing project		245,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		245,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 8.)

9. *Great Pee Dee River, South Carolina.*—This river, emptying into Win- w Bay at Georgetown, S. C., has (including its upper portion, called e Yadkin) a total length of about 500 miles, and a drainage area of ,329 square miles, of which 9,642 square miles lie above the mouth the Black, Lynche's, and Little Pee Dee rivers, its main tributaries. At eraw, at five-tenths of a foot above low water, the discharge is about 60 cubic feet per second. This river, prior to improvement in 1880, was dangerously obstructed with snags and logs everywhere, but was

otherwise available for 9-foot boats at ordinary stages of water to Smith's Mills, 67 miles above its mouth; and thence for 3.5-foot draught boats at low water 88 miles further, to Little Bluff, or at high water 183 miles further, from Smith's Mills to Cheraw, the present head of steam navigation, 250 miles above Georgetown. The commerce of this river is estimated to have then been about $400,000 of transported goods per year. The original project of 1880, as continued to date, proposed to secure a thoroughly cleared 9-foot navigation to Smith's Mills, and a 3.5-foot navigation to Cheraw at all stages of water.

During the last fiscal year ending June 30, 1886, while awaiting further appropriations, $829.02 was spent in mapping the river, in caring for the property and records, and in preparing reports and future projects.

Up to June 30, therefore, a total of $26,919.43 has been spent in all upon this improvement, giving at all ordinary stages of water a well-cleared 9-foot navigation 67 miles upward to Smith's Mills, and a fairly-cleared 3.5-foot navigation at low water, 83 miles further to the railroad station at Pee Dee, or at high water 183 miles further from Smith's Mills to Cheraw. The commerce of the river has thereby increased so as to be at present about $2,000,000 of transported goods per year, showing that each dollar spent upon this improvement has been accompanied by the development of about $59 annual commerce.

The Wilmington, Columbia and Augusta Railroad Drawbridge, 5 miles below Little Bluff, is improperly fendered; its obstruction is somewhat dangerous, and should be corrected. The Society Hill Drawbridge near Cheraw is improperly fendered; its obstruction is somewhat dangerous, and should be corrected.

The officer in charge recommends that this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 9-foot navigation 67 miles upward to Smith's Mills, and thence a 3.5-foot navigation 183 miles further to Cheraw at all stages of water, at a total expense of $70,000 in addition to the amount available for the fiscal year ending June 30, 1887, appropriated in two yearly installments of $40,000 and 30,000 respectively. Smaller appropriations will increase the cost.

It is estimated that the first installment can be profitably spent removing from the river channel the most troublesome sunken logs and snags, and in cutting down and pulling back from the river banks the most troublesome leaning trees, and also such as appear liable to fall into the river channel during the next year.

After the appropriation is finished, its proper maintenance may cost from $2,000 to $5,000 per year.

July 1, 1885, amount available		$909 5
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$489 30	
July 1, 1886, outstanding liabilities	339 72	
		829 0
July 1, 1886, amount available		80 5
Amount appropriated by act approved August 5, 1886		20,000 0
Amount available for fiscal year ending June 30, 1887		20,080 5
Amount (estimated) required for completion of existing project		70,000 0
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 0

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 9.)

10. *Waccamaw River, South Carolina.*—This river, emptying into the Winyaw Bay at Georgetown, has a total length of 244 miles, and

drainage area of 1,572 square miles of rich agricultural lands. This river, prior to Governmental improvement in 1880, was navigable for 12-foot-draught boats at all stages of water from Georgetown, Winyaw Bay, 26 miles to Bull Creek, and at high water 4 miles further, to Buck's Lower Mills; thence for 7-foot draught boats at high water 36 miles further to Conwayborough; thence it possessed an obstructed channel for 3-foot-draught boats at ordinary water 124 miles to Reeves Ferry, the present head of steam navigation; thence an obstructed channel with 3-foot depth at high water for 54 miles to Lake Waccemaw, which is 244 miles distant from Georgetown. The commerce of this river is estimated to have then been about $400,000 of transported goods per year. The original project of 1880, as continued to date, proposed to secure a channel 12 feet deep at all stages of water, with 80-foot bottom width from the mouth of the river 66 miles upward to Conwayborough, and afterwards a cleared channel 178 miles further to Lake Waccemaw.

Up to June 30, 1886, a total of $35,367.17 has been spent in all upon this improvement, giving a thoroughly cleared channel, with 100 feet least width and 6.8 feet least depth at high water as far as Conwayborough. The commerce upon this river has been thereby increased to about $1,300,000 per year, showing that each dollar spent on this improvement has been accompanied by the development of about $25 of annual commerce.

The officer in charge recommends that this improvement be completed in accordance with the present approved and adopted project; so far as at present to secure a channel 12 feet deep at mean low water, with 80 feet bottom width, from the mouth of the river 41 miles, up to Bucksville; and thence a channel 10 feet deep at mean low water, with 80 feet bottom width, 25 miles further, to Conwayborough; thence a thoroughly-cleared 3-foot navigation 24 miles further, to Reeves Ferry, throughout the entire year; and thence a thoroughly-cleared natural channel 54 miles further, to Lake Waccemaw, at a total expense of $88,000, in addition to the amount available for the fiscal year ending June 30, 1887; this amount to be appropriated in two yearly installments. Smaller appropriations will increase the cost of the work. Further improvement in accord with the original project, so as to secure a 12-foot navigation at all stages of water from Bucksville 25 miles, to Conwayborough, is not recommended at present.

After the improvement is finished its proper maintenance may cost from $1,000 to $4,000 per year.

It is estimated that the first installment can be profitably spent to secure a 12-foot navigation at high water from the mouth of the river 41 miles, to Bucksville, and a similar 10-foot navigation thence 25 miles upward, to Conwayborough; and towards securing a clear 3-foot steam navigation from Conwayborough 24 miles further, to Reeves Ferry.

July 1, 1885, amount available	$36 19
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3 35
July 1, 1886, amount available	32 84
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,032 84
Amount (estimated) required for completion of existing project	88,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	48,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L 10.)

11. *Harbor at Georgetown, South Carolina.*—Georgetown is situated at the head of Winyaw Bay, and at the confluence of the Sampit, Great Pee Dee, and Waccemaw rivers (the latter having conjointly a drainage area of 18,040 square miles), and is the natural harbor and sea-port for all commerce passing to and from these rivers and their tributaries. It is also a railroad terminus. This harbor prior to improvement in 1880 had an excellent, well-protected anchorage of at least one mile length, 150 feet width, and 15 feet depth. A bar of about 2,850 feet length and with only 9 feet depth of water was the only obstacle to an otherwise good 13-foot navigation from Georgetown 12 miles, to the ocean. The commerce of this harbor is estimated to have then been $2,000,000 of transported goods per year.

The original project of 1881, as continued to date, proposed to secure a dredged channel of 200 feet bottom width and 12 feet low-water depth entirely through this bar. No money was spent upon this improvement prior to June 30, 1884, because the available funds were too small to allow of being profitably spent.

During the last fiscal year, ending June 30, 1886, $3,552.91 was spent in widening the existing dredged channel, in caring for property and records, and in preparing reports and future projects. Further work was stopped for want of funds.

Up to June 30, 1886, therefore, $11,986.04 has been spent in all upon this improvement, giving a through cut entirely across the bar, with 12 feet low-water depth, and with a width varying from 40 to 80 feet. The commerce of the river is now about $3,500,000 of transported goods per year, an increase of $1,500,000 since 1880.

The officer in charge recommends that the above improvement be completed in accordance with the present and adopted project, so as to secure a channel of 12 feet depth at mean low water and of about 200 feet bottom width entirely through the bar, at a total expense of $22,000, in addition to the amount available for the fiscal year ending June 30, 1887; this amount to be appropriated in two yearly installments of $15,000 and $7,000, respectively. Smaller appropriations will increase the cost of the work. Further improvement is desirable in order to continue this channel by a similar easy, well-marked, and well-defined channel entirely through the upper portion of Winyaw Bay. With this object in view, a survey of the entrance to Georgetown Harbor through Winyaw Bay, S. C., is desirable, and is recommended as an extension of the Georgetown Harbor improvement.

The channel once thoroughly opened will probably be permanent. By this improvement ocean vessels of 12 feet draught, after once crossing Winyaw Bay Bar, can proceed without delay 15 miles further, to their anchorage at Georgetown.

It is estimated that the first installment of $15,000 can be profitably spent in a single year in widening the existing narrow channel.

July 1, 1885, amount available		$3,566 15
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,550 19	
July 1, 1886, outstanding liabilities	2 00	
		3,552 19
July 1, 1886, amount available		13 96
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,013 96

Amount (estimated) required for completion of existing project..........	$22,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888.	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L 11.)

12. *Santee River, South Carolina.*—This river, formed by the Congaree and Wateree rivers, and emptying into the Atlantic Ocean just south of Winyaw Bay, has, from the sea to its headwaters in the mountains, a total length of about 500 miles and a drainage area of 15,414 square miles. It was formerly navigated by 4-foot draught boats from the sea up to Columbia on the Congaree and Camden on the Wateree. In 1880, the date of commencement of the improvement, this navigation was considerably obstructed and blocked at all stages of water by sunken logs, snags, and floating timber. Its bar entrance was narrow, crooked, and shifting, with only about 4 feet depth of water at low tide, and so situated as to be very difficult and expensive to improve. Four steamers and a few small vessels were then running upon portions of this river. Its commerce is estimated to have then been about $600,000, and to now be about $1,400,000 of transported goods per year.

The original project of 1880 proposed to provide the river with a good outlet through Mosquito Creek to Winyaw Bay, by deepening and straightening this creek to 50 feet width and 7 feet depth, and to secure a safe and unobstructed 7-foot navigation in the river itself from its mouth, 154 miles upward, to Wright's Bluff; and thence a similar 5-foot navigation 30 miles further to its head in the Congaree and Wateree rivers.

The appropriation of 1881, and since, provided only for work upon the outlet of the river through Mosquito Creek to Winyaw Bay; and the approved project for 1881 for this expenditure, as continued to date, proposed to secure to the river a straightened canalized outlet through Mosquito Creek 7 miles long, 30 feet wide, and 6 feet deep at mean low water, and to construct one draw-bridge over the creek.

During the last fiscal year ending June 30, 1886, $14,993.62 was spent in extending the Mosquito Creek Canal, in building the draw-bridge, and in making necessary surveys, examinations, and reports. The work of dredging was stopped in November for want of funds.

Up to June 30, 1886, therefore, $55,346.37 has been spent in all upon this improvement, in cutting 15,610 linear feet of canal 30 feet wide and 5 feet deep, from Santee River along Mosquito Creek toward Winyaw Bay, and in building the proposed draw-bridge. No improvement of commerce has yet been produced, nor was any to be expected therefrom until the canal should be finally completed.

The Northeastern Railroad Drawbridge, between the mouth of the river and Wright's Bluff, is improperly fendered; the obstruction is somewhat dangerous and should be corrected.

The officer in charge recommends that this improvement be completed in accordance with the present approved and adopted project of 1881, so as to secure to the Santee River a straightened canalized outlet through Mosquito Creek 7 miles long, 30 feet wide, and 6 feet deep, at mean low water, at a total expense of $71,000 in addition to the $1,653.63 available June 30, 1886, this amount to be appropriated in two yearly installments of $48,000 and $23,000, respectively; also that this improvement be extended in accordance with the proposed original project of 1880, so as to secure a safe and unobstructed 7-foot navigation from the mouth of the Santee River 154 miles upward to Wright's Bluff, and thence a similar 5-foot navigation 30 miles further to its head in the Congaree and Wateree rivers, at a total expense of $75,000, to be appropriated in two yearly installments of about $40,000 each. Smaller appropriations will increase the cost of the work. It is estimated that this last recommended improvement would at once (as already shown by past experience on the neighboring Pee Dee River) increase the Santee River commerce from $1,000,000 to $2,000,000 per year. Further improvement, so as to increase the above widths and depths of either canal or river, is not recommended until commerce shall have shown a further immediate necessity therefor.

After this improvement is finished its proper maintenance may cost from $3,000 to $5,000 per year.

It is estimated that $48,000 can be profitably spent in a single year in opening the canal to vessels of about 20 feet width and 4 feet draught, and in removing in part from the river channel its sunken logs and snags, and cutting down and pulling back from its banks such trees as overhang the channel or might soon fall into the channel from caving banks.

July 1, 1885, amount available		$16,647 05
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$14,557 33	
July 1, 1886, outstanding liabilities	436 09	
		14,993 42
July 1, 1886, amount available		1,653 63
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		20,403 63
Amount (estimated) required for completion of existing project		71,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		48,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 12.)

13. *Wateree River, South Carolina.*—This river, which unites with the Congaree to form the Santee, has (including its upper portion, called the Catawba) a total length of about 310 miles, and a drainage area of 5,642 square miles. This river, prior to Governmental improvement in 1882, had a low-water depth of from 3 to 4 feet from its mouth in the Santee upward 64 miles to Camden, its practical limit of steam navigation. From its mouth upward 12 miles the river was completely blocked at all stages of water by sunken logs and stumps and by floating obstructions; thence 42 miles to Camden navigation was possible, but dangerous, except during high water. Its commerce was then almost nothing.

The original project of 1881–'82, as continued to date, proposed to secure a safe and unobstructed 4-foot navigation over this entire distance at all stages of water.

During the last fiscal year ending June 30, 1886, while awaiting further appropriations, $238.46 was spent in mapping the river, in caring for the property and records, and in preparing reports and future projects.

Up to June 30, 1886, therefore, a total of $27,965.63 has been spent in all upon giving a thoroughly cleared 4-foot navigation upon this improvement at all stages of water from the mouth of the river 7 miles upward; and thence a roughly cleared 4-foot navigation over the rest of the 57 miles to Camden. In consequence of this improvement a steamboat line would have been permanently established upon the whole length of the river had it not been prevented by the obstructions offered by two low railroad bridges.

This long desired and now possible navigation is obstructed at present only by the South Carolina Railroad and the Wilmington, Columbia and Augusta Railroad, who should either raise or put draw-spans in their two low through-bridges across the river near its mouth. If the railroad obstructions can be removed, it is estimated that the river commerce will increase at once by about $1,000,000 of transported goods per year.

It is recommended that this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly-cleared 4-foot navigation over the entire river at all stages of water, at a total expense of $22,500 in addition to the amount available for the fiscal year ending June 30, 1887; this amount to be appropriated in one sum during the next year. Smaller yearly appropriations will increase the cost. Further improvement so as to extend the navigation above Camden or to deepen that below Camden is not recommended.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

It is estimated that the appropriation asked can be profitably spent in a single year in removing from the river channel its sunken logs and snags, and in cutting down and pulling back from its banks such trees as overhang the channel or as might soon fall into the river channel from caving banks.

July 1, 1885, amount available		$272 83
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3 71	
July 1, 1886, outstanding liabilities	234 75	
		238 46
July 1, 1886, amount available		34 37
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,534 37
Amount (estimated) required for completion of existing project		22,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		22,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 13.)

14. *Removing sunken vessels obstructing or endangering navigation.*—The wrecks of the brig Clio and steamer North Heath, in the Cape Fear River, below Wilmington, were examined and reported as obstructing and endangering navigation.

After the usual preliminaries, a contract was approved June 23, 1886, for the removal of both these wrecks within the following four months. There were no expenditures upon this work prior to June 30, 1886.

The circumstances connected with the removal of these wrecks suggest to the officer in charge some modification of the act of June 14, 1880, so as to allow the Secretary of War some discretion as to whether the wreck after removal may not in certain cases become the property of the contractor. Such a modification in the act might result in economy to the Government.

(See Appendix L 14.)

IMPROVEMENT OF RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA AND GEORGIA, AND PART OF THE ATLANTIC COAST OF FLORIDA.

Officer in charge, Col. Q. A. Gillmore, Corps of Engineers, having under his immediate orders First Lieuts. F. V. Abbot and O. M. Carter, Corps of Engineers.

1. *Charleston Harbor, South Carolina.*—The works of improvement now in progress of construction comprise two jetties, composed of riprap stone resting on a broad foundation mattress of logs and brush, with a mattress hearting wherever deemed expedient and advantageous.

The two jetties spring, respectively, from Sullivan's and Morris islands, and converge towards each other on curves in such manner as to cross the bar on parallel lines at a distance of about 2,900 feet from each other. The object of the work is to establish and permanently maintain a practicable channel across the bar of not less than 21 feet navigable depth at mean low water, where heretofore the available low-water depth has usually not exceeded 11½ feet.

A greater navigable depth than 21 feet at mean low water can be obtained by increasing the length of the jetties and building them higher.

Previous to the adoption of this project in 1878 there had been expended in improving this harbor since the close of the civil war, from 1871 to 1878, the sum of $93,700 in taking up the wrecks of fourteen iron-clads and wooden vessels, and for other purposes.

The estimated cost of the project is $3,000,000.

The following work on jetties is reported to have been done during the past fiscal year:

North Jetty.—A second course of log-and-brush mattresses, 55 feet wide and covered with about 12 inches of rip-rap stone, was laid over the bottom course of the jetty, extending 2,030 feet seaward from a point 11,090 feet from the shore end on Sullivan's Island, measured along the axis of the work. A pile of riprap stone, nominally 5 feet high at the ridge line, with natural side slopes, was deposited upon work previously laid, beginning at a point 9,193 feet from shore and carried seaward for a continuous length of 4,485 feet. The outer end of this pile of rock work reaches a point about 560 feet from the present seaward end of the bottom course of the north jetty.

South Jetty.—The foundation course of this jetty was extended seawar 43 feet by laying a log-and-brush mattress of that length and of 108 fee width. A third course of mattresses, 44 feet wide, was placed upon that section of second-course work which had been laid about two and a hal years ago where the jetty crosses the deep pocket east of the existin main ship-channel. This third course commences at a point 7,986 fee from the shore end of the work on Morris Island and extends 1,206 fee seaward. A ridge of riprap work, triangular in cross-section, and av eraging 4.6 feet in height, was deposited upon the existing work, begin ing at the inner end of the third course just mentioned and extendin 6,038 feet seaward. During the past fiscal year 18,289 square yards o log-and-brush mattresses and 15,341 cubic yards of riprap stone wer put in the work on the two jetties, and the sum of $97,212.92 was ex pended. Previous to July 1, 1885, the total expenditures amounted t $1,197,732.08.

On June 30, 1886, the seaward end of the north jetty reached a poin 14,327 feet from the shore of Sullivan's Island, measured along the axi of the work, and 1,200 feet within the outer 18-foot curve of the ba ken on the prolongation of the axis of the jetty. By a similar way measurement, the outer end of the south jetty was 16,440 feet from e shore of Morris Island, and 2,500 feet from the outer 18-foot curve the bar.

Dredging between the jetties was carried on during the first six onths of the past fiscal year; 76,620 cubic yards of material were re-oved during that time. It appears from the report of the engineer ficer in charge that the average height now attained by the north jetty 4.95 feet, while the height required under the project is 10.66 feet. he contraction of the water-way is at present 46½ per cent. of what should be. The mean height of the south jetty on June 30, 1886, was 95 feet; ultimate height required, 11.23 feet; the contraction of the ater-way at the same time was 53 per cent. of what is required by e project. These results show that a considerable amount of addi-ional work is needed to develop scouring currents of sufficient strength etween the jetties to produce and maintain the new channel.

Both jetties were generally in good order at the end of the fiscal year, ith some unimportant exceptions. For a short length the apron of he north jetty at Drunken Dick Shoal has settled somewhat, but other-ise sand had freely accumulated over the work in that section. Near he outer end of the north jetty the apron seems to be a good deal oken up, probably by the action of the waves. Considerable scour-ng has taken place on the south side of the south jetty where it crosses the deepest of the Morris Island ship-channel, but the work does not eem to have settled in consequence. Some settling has occurred at and near the outer end of this jetty. The ridges of riprap stone placed ver portions of both jetties have been lowered by the action of the waves and the stone spread out over the mattress work below. No aterial changes of the bar between the jetties are reported. Jim Ev-s's Shoal is about in the same condition as last year, but has moved ightly seaward. The area of Swash Reef, between the 9-foot curves, s diminished one-half during the year. Some deepening has been roduced by dredging, but the form of the cut dredged has been oblit-rated by the shifting sand. Pumpkin Hill Channel, for many years e channel of entrance across the bar, has fallen into disuse towards e end of the fiscal year, and a more southerly channel located practi-lly in the prolongation of the axis of the main ship-channel has taken place.

The sea-beach of Sullivan's Island east of Bowman's Jetty has changed t little, but to the west of that work washing has continued. The e is reported of the northern end of Morris Island, and some lower-g of the beach has taken place in the vicinity of the south jetty.

The two spur-jetties built in 1884 for the protection of a part of the re of Mount Pleasant, are stated to be in good condition and col-ting sand at their inner ends, but caving of the bluff continues at er points of the shore-line.

The progressive widening of Hog Island Channel at its upper end, out which the engineer officer in charge made some remarks in his t annual report, is again referred to in his present report, and he re-ats his opinion that works should be built to prevent further enlarge-nt.

With the first money that becomes available the north and south jet-s will be raised to higher levels, and dredging will be resumed if the ds at disposal shall be sufficient for that purpose.

The appropriations made by Congress for this improvement to the last appropriation, amounting to $5,000, was made by the act approved July 5, 1884.

The Edisto is one of the principal rivers in South Carolina. It is formed by the junction of the North and South forks, which unite in the southern part of Orangeburg County. The South Fork, commonly known as the South Edisto, is the main river.

The obstructions to navigation consist of numerous bends, logs, snags, overhanging trees, and piles; also of shoals, generally of sand, but in some places of hard clay.

The plan of improvement contemplates the establishment of a safe navigation channel at all seasons of the year for light-draught steamboats from the sea to the junction of the North and South forks, a distance of 183 miles, and from that point to Guinguard's Landing, 77 miles higher up, for rafts and flat-boats. The plan embraces enlarging all the new channels now in progress of formation, cutting off bends, shutting off lateral arms of the river, removing shoals, snags, logs, piles, and other obstructions, and building a deflecting jetty. The cost of the project is estimated at $33,385.

No operations were carried on during the past fiscal year owing to lack of funds.

Prior to July 1, 1885, a large number of snags, logs, overhanging trees, and piles were removed from the reaches extending from the mouth of the Edisto to Kennedy's Bridge, a distance of 130 miles by river. A narrow cut-off known as the "Suck," 50 miles above Jacksonboro', through the neck of a long bend, was widened and deepened and made the regular channel of the river. Many outlets, feeding adjoining swamps, and incipient cut-offs were closed, and the river banks trimmed at numerous places. The cost of these works to June 30, 1885, was $12,629.86.

It seems that the raft navigation of the Edisto, on the reaches where operations were carried on, has been substantially benefited. Lumbermen state that their products can now more economically be brought from mill to market, as trips can be made in much shorter time and with less risk; which saving is to a large extent attributed to the improvements made by Government.

The Engineer officer in charge recommends that the necessary appropriations be made to complete the improvement according to the approved project.

The total expenditures to June 30, 1886, were $12,719.33.

July 1, 1885, amount available	$370 14
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	89 47
July 1, 1886, amount available	280 67
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,280 67
Amount (estimated) required for completion of existing project	17,385 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M 4.)

5. *Salkiehatchie River, South Carolina.*—The appropriations heretofore made and expended on this improvement aggregate $8,000.

The Salkiehatchie, known as the Big Salkiehatchie, to distinguish it from its principal tributary, the Little Salkiehatchie, rises in Aiken

County, S. C., and flows into the Atlantic Ocean. The two rivers unite about 80 miles from the sea-coast. The lower part of the river is known as the Combahee. Above a point named Hickory Hill, about 44 miles from the sea-coast, the river is obstructed in many places by piles, logs, and sand-shoals.

The project of improvement contemplates the establishment of a continuous channel, suitable for flat-boats and rafts, from a point 5 miles above Toby's Bluff down to Hickory Hill, a distance of about 77 miles by river.

The work comprises the removal of logs, shoals, and piles, and cutting a navigable channel through two places known as Murdoc Sand Drags and Weckly Sand Drags, where the river at present is divided into numerous small streamlets unfit for any kind of navigation. The cost of the project was estimated at $18,000.

No work was done on the river during the last fiscal year, as no funds were available.

Previously the United States snag-boat Toccoa cleared the 12-mile reach, from the Charleston and Savannah Railroad Bridge down to Hickory Hill, from piles and other obstructions. Between 11,000 and 12,000 snags, logs, and trees were removed from several reaches of the river above the bridge as far as Braxton's Ford, a total length of 80 miles; over one hundred outlets were closed; many projecting points were cut off, and the channel straightened.

The Engineer officer in charge reports that raft navigation on the Salkiehatchie has been materially benefited by the work done by the Government, and that thereby the cost of rafting timber has been reduced from 33 to 50 per cent. from former rates. He further states that the reaches where improvements have been effected have remained in the same condition substantially in which they were when work was suspended in May, 1885.

It seems desirable that the necessary funds be provided by Congress to finish the upper section of the river in conformity with the project. The sum of $10,000 is required for the purpose. The total expenditures to June 30, 1886, were $7,924.17.

July 1, 1885, amount available	$141 10
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	65 27
July 1, 1886, amount available	75 83
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,075 83
Amount (estimated) required for completion of existing project	8,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M 5.)

6. *Savannah Harbor and River, Georgia.*—During a part of the past fiscal year operations were carried on in conformity to the enlarged project of January 16, 1882.

This plan contemplates the establishment of a channel from Tybee Roads to the city of Savannah, navigable for vessels of 22 feet draught, and the widening of the river opposite the city to 600 feet of uniform depth with the balance of the channel. This is to be accomplished by improving the north channel in preference to the south channel, from the head of Elba Island to the head of Long Island, closing with dams all the lateral channels connecting the north and south channels from Elba Island to Tybee Roads; constructing a low dam across the south channel above Saint Augustine Creek, in order to increase the volume of ebb-flow down the north channel, raising the dam at Cross-Tides 4 miles above the city of Savannah to a higher level, possibly to the level of high water; narrowing the river between Savannah and Tybee Roads by wing-dams where the widths are excessive and navigation poor; constructing a low jetty or training-wall from some point on either Jones or Turtle Island, in a southerly direction to the Red Light Beacon, and protecting Saint Michael's Channel below that beacon by a similar wall or by some other device. Works of shore protection will be built and dredging done wherever deemed necessary. The estimated cost of the improvement according to the plan submitted January 16, 1882, is $730,000.

The following is a summary of the work done previous to July 1, 1885:

The Cross-Tides Dam had been built up to the level of mean high water, and at places where it had settled its base was protected by an apron of log mattress and stone. A portion of the old King's Island jetty had been removed; three wing-dams for reducing the width of the water-way were constructed opposite the lower part of the city, and a fourth lower down, near the lower end of Fig Island; a training-wall was built extending 6,000 feet down-stream from the lower end of Fig Island, with its crest from 3 to 5 feet above mean low water, and eleven short spurs added to the wall on its channel side; a sumerged dam was built across the South Channel, near the head of Elba Island; two side channels northwest and southeast of Barnwell Island, above Elba Island, and three side channels below that island were closed by dams; a wing-dam was constructed to improve the channel at "The Obstructions" between Barnwell Island No. 3 and the head of Elba Island; three pairs of wing-dams were built to regulate and improve the channel at the "Upper Fats"; one pair of wing-dams was completed and a single one about two thirds finished at the "Lower Flats" or "Cabbage Tree Crossing"; a fifth pair was built lower down to improve the shallow passage at "Long Island Crossing", and a dam was commenced at the mouth of the river, designed to improve the ship-channel northwest of Fort Pulaski, near the Oyster Bed Beacon. The channel was dredged at numerous points of the river from the Cross-Tides Dam to Tybee Roads, an aggregate of 1,667,233 cubic yards of material having been removed.

The following work was done during the past fiscal year:

Cross-Tides Dam, the central portion of which had been washed down to the level of low water, was again raised to the required height, and other subsequent damages were repaired as far as practible. The closing-dams at Philbrick's Cut and Big Gap, below Elba Island, which had practically settled, were again raised to the level of high water.

The crest of the Fig Island Jetty was brought up to a uniform height of about 5 feet above mean low water. Three wing-dams at the Upper Flats, and the two at Long Island Crossing, all of which had settled at a number of places, were repaired; 38,474 cubic yards of material were removed from the channels at Garden Bank, "The Wrecks," "The Obstructions," and Upper and Lower Flats, by dredging.

The Engineer officer in charge states that other breaks have occurred in Cross Tides Dam, by which for a length of about 300 feet the crest has been more or less lowered, and that these damages, to a considerable extent, are caused by fishermen and others who are interested in keeping a passage open across the dam for their boats. The cyclone which visited the South Atlantic coast in August, 1885, caused more or less damage to the Fig Island Jetty, to the wing-dams at the Lower Flats and Long Island Crossing, and to the unfinished dam at Oyster Bed Shoal. Otherwise the works are in good condition. The river is reported to be in excellent condition; the draught of vessels that can enter and leave the port is increasing; in one instance last year a vessel drawing 20¾ feet was brought in, which had never before been accomplished. As a matter of fact a permanent increase of draught of from 3 to 3½ feet has been produced in the navigable channel within the past five or six years, as a result of the operations carried on during that period for the improvement of the river.

In view of this fact, the Engineer officer in charge recommends that a liberal appropriation be made by Congress for completing the work of improvement.

The total estimated cost of the work is $1,212,000.

The total appropriations made since 1874 up to June 30, 1885, were $882,000; the expenditures to June 30, 1886, were $879,056.10.

July 1, 1885, amount available		$50,385 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$47,168 21	
July 1, 1886, outstanding liabilities	273 49	
		47,441 70
July 1, 1886, amount available		2,943 90
Amount appropriated by act approved August 5, 1886		150,000 00
Amount available for fiscal year ending June 30, 1887		152,943 90
Amount (estimated) required for completion of existing project		180,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		180,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867		

(See Appendix M 6.)

7. *Savannah River, Georgia.*—Three appropriations, aggregating $55,000, have been made by Congress for improving Savannah River between the cities of Augusta and Savannah since the present plan of improvement was adopted. On this section of the river navigation was seriously obstructed at several places during the dry season by extensive shoals or sand-bars, with only 2 or 3 feet of water over them, and at numerous other points by snags, floating and overhanging trees, and piles.

The plan of improvement contemplates the creation of a low-river channel of 5 feet depth over all shoals of less depth, and clearing the river of other obstructions to navigation. For these purposes wing-dams were to be built for narrowing the river where the widths are excessive; deposits of silt to be promoted along the banks by light hurdle-works; caving banks revetted where necessary; projecting points to be cut away; snags and other obstructions to be removed, and dredging to be done where necessary to assist the formation of a low-river channel. The cost of the project is estimated at $91,000.

No work was done during the past fiscal year, owing to want of funds.

The following operations have thus far been carried on: A suitable snag-boat was constructed and put to work in removing obstructions from near Augusta down to Saxon's Landing, 142 miles from that city. Large numbers of snags, piles, stumps, and leaning trees were taken out, and the wrecks of several flat-boats removed. The channel at Gardner's Bar and Course's Bar, just below the city, was improved by wing-dams constructed from the bank opposite the city, and the caving banks on the city side were strengthened. Wing-dams were also built at Sand-Bar-Ferry Bar, 4 miles above the city, and at Blue House Bar, 2 miles lower down.

The Engineer officer in charge was unable to report upon the present condition of the works, as during the latter part of the fiscal year the high stage of the river prevented an examination. It is stated, however, that no complaints have been received relative to the navigation at the improved reaches during low-river stages.

Several bars remain to be improved, and numerous other obstructions have yet to be removed.

It is recommended by the Engineer officer in charge that any funds that may be made available be applied to the construction of wing-dams at points lower down the river where required, and to resume the work of removing snags and other obstructions from the channel-way.

The total expenditures from the beginning of operations to June 30, 1886, were $57,264.85.

July 1, 1885, amount available	$514 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	279 02
July 1, 1886, amount available	235 15
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,235 15
Amount (estimated) required for completion of existing project	21,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	21,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M 7.)

8. *Savannah River above Augusta, Georgia.*—No operations were carried on during the past fiscal year, as no appropriation for continuing the work had been made, and nothing has been done since August, 1883.

Three appropriations, aggregating $39,000, have been made by Congress for improving this portion of the Savannah River, which amount has been expended, with the exception of a small balance still on hand, for work done in conformity to the first of two projects submitted by the Engineer officer in charge under date of February 8, 1879, which contemplates the improvement of the river for pole-boats only from the city of Augusta up to Trotter's Shoals, a distance of 64 miles. The cost of the project was estimated at $45,000. The obstruction to pole-boat navigation consisted chiefly in rock ledges running across the channel, bowlders of various sizes, and shoals of gravel. On many shoals there is but 1 to 2 feet of water during low-river stages.

The project is designed to create a clear channel of 30 feet width and 3 feet depth at low water.

At numerous points the channel-way was improved, especially in the lower reaches. From the canal lock, 7 miles above the city of Augusta, to Barkdale Ferry, a distance of 50 miles, a channel was established through the obstructions 20 feet wide and 2½ feet deep at summer low water. For this purpose a large quantity of ledge-rock, with some bowlders and gravel, had to be removed and a considerable number of wing-dams built.

The total expenditures to June 30, 1886, were $38,177.29.

July 1, 1885, amount available	$877 06
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	54 35
July 1, 1886, amount available	822 71
Amount (estimated) required for completion of existing project	6,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix M 8.)

9. *Saint Augustine Creek* (*Thunderbolt River*), *Georgia.*—No work has been done here since September, 1880, and no appropriation is asked for.

July 1, 1885, amount available	$3,417 66
July 1, 1886, amount available	3,417 66

(See Appendix M 9.)

10. *Romerly Marsh*, *Georgia.*—Two appropriations aggregating $20,000 have been made by Congress for improving Romerly Marsh. The act by which the first of these appropriations was provided directed that the improvement be carried on "by the route designated in the survey of the engineers as route numbered four."

The water-route through Romerly Marsh forms part of the inland passage between the Savannah River, Georgia, and Fernandina, Fla. The marsh is situated between Wassaw Sound on the north and Ossabaw Sound on the south. The route lately used was objectionable from its excessive crookedness and deficiency in depth. Vessels drawing 5 feet of water could not pass through on less than half-tide.

In his report of an examination of Romerly Marsh, the Engineer officer in charge described four different routes that might be adopted in preference to the existing passage. Either one of the lines suggested was designed and recommended to receive a low-water depth of not less than 7 feet and a bottom width of 48 feet.

Route number 4, named in the act, is the most easterly one of those examined, and nearest to the ocean. By this route Dead Man's Hammock Creek, which flows through the marsh and empties into Wassaw Sound, is to be connected by a solid cut of about 1,160 yards length with Wassaw Creek, which flows into Odingsell River near the point where the latter discharges into Ossabaw Sound. The cost of establishing route number 4 was estimated at $38,720.

This estimate has been exceeded, owing chiefly to repeated stoppage of operations from lack of funds, which made it necessary to do part of the work over again.

Prior to July 1, 1885, the cut had been opened for a length of 1,720 feet, beginning at Dead Man's Hammock Creek or at the northerly end. This cut was 40 to 50 feet wide at the bottom, and had 7 feet depth at mean low water. The material removed amounted to 101,100 cubic yards. The total expenditures to June 30, 1885, including the sum of $5,000 contributed by the Georgia and Florida Steamboat Company, were $21,156.63.

During the past fiscal year the cut was completed and a channel of 50 feet bottom width and 7 feet depth at low water was obtained through the marsh and through the shallow water south of it until sufficiently deep water in Wassaw Creek was reached. The total length of solid marsh cut was 3,547 feet; 110,463 cubic yards of material were removed during the year.

The total cost of the completed work is $46,712.57.

As the appropriations made by Government amounted to only $20,000, this improvement could not have been finished if funds had not been supplied by the Inland Steamboat Company and other parties who were interested in its speedy completion. The money thus provided was expended under the supervision of the Engineer officer in charge, under conditions approved by the Secretary of War.

It appears from a recent examination of the work that for all practical purposes the new route is in a condition which is in accordance with the project.

For reasons stated in his report the Engineer officer in charge recommends that the private parties who during the past fiscal year supplied the funds necessary for completing the work be reimbursed by Government.

July 1, 1885, amount available		$3,843 37
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,346 70	
July 1, 1886, outstanding liabilities	100 47	
		3,447 17
July 1, 1886, amount available		396 20
Amount appropriated by act approved August 5, 1886		17,475 00
Amount available for fiscal year ending June 30, 1887		17,871 20
Amount (estimated) required to pay for completion of existing project. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		5,625 00

(See Appendix M 10.)

11. *Altamaha River, Georgia.*—Three appropriations, aggregating $35,000, have thus far been made by Congress for the improvement of Altamaha River.

The Altamaha is the most important river lying entirely within the State of Georgia. It is formed by the confluence of the Oconee and Ocmulgee. Its length is 155 miles. It has a southeasterly course, and empties into the Atlantic Ocean through Altamaha Sound below the town of Darien. It has been badly obstructed by rock ledges, sand-bars, and snags; and the plan of improvement provides for their removal, so as to secure a navigable low-river channel 80 feet wide and 3 feet deep, at a cost roughly estimated at $60,000. The engineer officer in charge states that this estimate will be exceeded by $15,000 in order to provide for wing-dams and training-walls, not included in the original estimate, at some points where sand-bars exist.

The first expenditure, prior to July 1, 1885, was incurred in paying part of the expenses of building and equipping a suitable snag-boat; the entire first appropriation—$5,000—was applied to that purpose Since then this boat has removed nearly one thousand snags, logs, overhanging trees, and piles. An improved channel of 100 feet width and 4 feet depth at summer low water was opened through the rock-bars at Town Bluff and Piney Bluff, 1⅝ and 19½ miles, respectively, below the junction of the Oconee and the Ocmulgee. The shallow crossing at Beard's Bluff Bar, 63 miles below the junction, was improved by a training-wall 1,750 feet in length, with two short spurs on the channel side, built to reduce the excessive width of the river at this point. The caving bluffy bank was protected by a fascine revetment. The expenditures to June 30, 1885, aggregated $32,085.34.

All that could be done during the last fiscal year, with the small amount of funds on hand at its beginning, consisted in completing the work at Beard's Bluff Bar. Four spur-jetties were added to the training-wall, and the revetment on the opposite bank was finished.

The total expenditures to June 30, 1886, were $34,458.13.

At the close of the last fiscal year the channel was in good condition at the reaches where improvements had been made, except that some bowlders have been found that interfere with navigation at Town Bluff and Piney Bluff. These will have to be removed, and other reaches require improvement, as provided for in the existing project, before a clear channel can be secured through the entire length of the Altamaha.

The Engineer officer in charge names in his report a number of points on the river where work should be done as soon as an additional appropriation is made, and recommends that Congress should provide funds to complete the improvement of Altamaha River, and to commence that of Darien Harbor and Bar.

July 1, 1885, amount available		$2,914 66
July 1, 1886, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1885	$2,332 79	
July 1, 1886, outstanding liabilities	40 00	
		2,372 79
July 1, 1886, amount available		541 87
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,541 87
Amount (estimated) required for completion of existing project		20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix M 11.)

12. *Brunswick Harbor, Georgia.*—Operations for improving Brunswick Harbor, in general accordance with a project submitted by the Engineer officer in charge on April 29, 1876, modified in his annual report, dated July 22, 1880, have intermittently been carried on from May, 1880, to May, 1885, by means of five successive appropriations aggregating $70,000.

That project comprises the construction of a jetty starting from the northeasterly end of Buzzard Island, and located approximately parallel to and 1,000 feet distant from the established pier-head line on the opposite shore, for the purpose of contracting the water-way and concentrating the current upon a shoal about 1 mile below the town of Brunswick. The bottom being hard and tough, expensive dredging has been necessary.

The object of these works was to establish and permanently maintain a channel not less than 15 feet deep at mean low tide over the shoal on which heretofore the navigable low-water depth was only 9 feet. The cost of the project was estimated at $73,187. This estimate did not include works that might eventually be needed at the upper end of East River, a loop of the main stream on which Brunswick is situated.

An appropriation of $10,000 was made for this locality in 1836, and expended in dredging on the shoal referred to.

The Engineer officer in charge states in his annual report that the existing project must be modified, or rather enlarged, in order permanently to secure the lowering of the refractory shoal in Brunswick River (East River) to a minimum low-water depth of 15 feet. His report gives the outlines of the enlarged plan, which embraces the existing project, and provides in addition for a low dam across Turtle River, at the upper end of Buzzard Island, and dredging in that vicinity; short spur-jetties in the lower part of Brunswick River; raising the existing jetty to a higher level, and additional dredging on the shoal in that river. The cost of the enlarged plan is estimated at from $190,000 to $200,000, inclusive of the appropriations heretofore made for Brunswick Harbor.

No work was done during the last fiscal year, there being no funds available.

The following is a summary of the work thus far accomplished. The main line of the jetty was laid to a length of 4,199 feet, reaching the outer 18-foot low-water curve of the main stream, or Turtle River. At the upper end the jetty is connected with the shore of Buzzard Island by a spur or return face 310 feet in length. This spur and the adjoining 780 feet length of jetty are formed of palmetto cribs attached to platforms of round logs, and filled with brush and material obtained by dredging, and topped off with riprap stone. The outward portion of the jetty, a length of 3,419 feet, is composed of log mattresses, double-raft style, covered with brush and riprap stone. The top of the return face has been raised by means of log mattresses and stone, resting upon the crib-work below, to the height of from 2 to 3 feet above low water, and an apron of mattresses and stone protects the base of the return face and the adjacent portion of the jetty from scour. On the main line the ridge of stone-covering upon the crib-work is a few feet below the level of low water; that of the mattresses further down reaches up to that level, except at the outer end, where it is lower.

The material removed by dredging aggregated 80,502 cubic yards; the dredging operations were carried on upon lines about parallel to the jetty and 720 feet from it. Three cuts were made through the shoal to a low-water depth of 15 feet, each cut being from 4,400 to 4,800 feet in length and from 20 to 25 feet in width. A fourth cut is about 1,500 feet long and 12 feet deep at low water.

The channel thus obtained by dredging has shoaled more or less during the last three years, showing that additional works are needed to control and strengthen the ebb-currents. The jetty work is in good order.

The total expenditures to June 30, 1886, were $69,871.81.

With any funds that may become available it is proposed to raise the existing jetty to a higher level and begin the work of improvement at the upper end of Buzzard Island, in conformity to the enlarged project submitted by the Engineer officer in charge.

July 1, 1885, amount available		$387 43
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$125 47	
July 1, 1886, outstanding liabilities	133 77	
		259 24
July 1, 1886, amount available		128 19
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		22,628 19
Amount (estimated) required for completion of existing project		97,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		75,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix M 12.)

13. *Entrance to Cumberland Sound, Georgia and Florida.*—Four appropriations, aggregating $255,000, have thus far been made by Congress for the improvement of the entrance to Cumberland Sound, in conformity to the plan described in general terms in a report of the Engineer officer in charge, dated June 30, 1879, contained in Appendix I 8, Annual Report of the Chief of Engineers for 1879.

The project consists essentially of two low jetties, composed of riprap stone, resting on a broad foundation-mattress of logs, or logs and brush, starting respectively from the opposite shores of the entrance and extending seaward across the bar upon lines so directed that the outer ends will be approximately parallel to each other, and from 3,000 to 3,500 feet apart, or such distance as may hereafter be adopted. The estimated cost of the improvement with two long jetties is $2,071,023. They are calculated to maintain a low-water depth across the bar of not less than 20 to 21 feet, or a high-water depth of 26 to 27 feet. Heretofore the depth on the bar has varied from 11 to 12½ feet at mean low tide, with exceptional depths 1 foot greater.

No work has been done on the jetties during the last fiscal year from want of funds.

The following is a summary of the work done to the present time: The foundation-course of the north jetty, consisting of a log-and-brush mattress overlaid with riprap stone, has reached a point 7,372 feet from the shore of Cumberland Island. Its width varies from 25 to 52 feet, and its thickness through log and brush from 19 to 22 inches. A second course of mattresses, of similar thickness, from 20 to 25 feet width, covered with riprap stone, and of an aggregate length of 1,490 feet, was laid upon the foundation-course along the deeper portions of Cumberland Channel. Foundation-mattresses for two spurs were also laid here on the south side of the jetty. The bottom course of the south jetty has reached a point 7,667 feet from its shore end on Amelia Island. From that point for a length of 4,160 feet the widths of mattresses vary from 40 to 87 feet; further out to the seaward end the mattresses have a uniform width of 100 feet.

An aggregate sum of $251,301.69 had been expended upon the work here described to June 30, 1885.

Two surveys of the bar were made during the past fiscal year, the first in July and August, 1885, and the second in June, 1886. It appears that the jetty work is in good condition, except that exposed logs are worm-eaten. The shore lines near either jetty are advancing seaward. The local deepening where the north jetty crosses Cumberland Channel is still increasing and seems to call for preventive measures. The inner 18-foot low-water curve has during the last three years advanced about 1,650 feet toward the crest of the bar, extending about one-fourth of a mile in advance of the present outer end of the south jetty. Depths have generally increased on the bar. The Engineer officer in charge calls attention to the fact that the northern marginal 12-foot curve of Amelia Basin has pushed out at a certain point from 1,200 to 1,500 feet northward, indicating that a new northward channel may break out here that might ultimately take the place of Cumberland Channel unless prevented by an early extension of the north jetty. The sailing line over the bar has of late years approached the south jetty, from which it is now about 600 feet distant. The least available low-water depth in the bar channel is reported to be at present 14 feet.

The sum of $2,933.67 was expended during the last fiscal year for making surveys and examinations, care and preservation of plant, &c.

The Engineer officer in charge concludes that the extension of both jetties should be proceeded with vigorously to promote the development of the favorable changes that have occurred on the bar. Any funds that may be provided he recommends to expend for such extension of the jetties, for raising them to a higher level, and for taking the necessary precautionary measures where local deepening has occurred in Cumberland Channel. The total expenditures to June 30, 1886, were $254,235.36.

July 1, 1885, amount available		$3,698 31
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,566 69	
July 1, 1886, outstanding liabilities	366 98	
		2,933 67
July 1, 1886, amount available		764 64
Amount appropriated by act approved August 5, 1886		112,500 00
Amount available for fiscal year ending June 30, 1887		113,264 64

Amount (estimated) required for completion of existing project	1,693,523 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	500,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M 13.)

14. *Inside passage between Fernandina and Saint John's River, Florida.*—Nothing has been done for improving this route since the last suspension of operations, on December 1, 1880. The work has not been resumed for the reason given by the Engineer officer in charge that there seemed to be not only no urgent need for its continuance, but no prospect of securing any permanent improvement from the expenditure of small appropriations.

July 1, 1885, amount available	$4,434 45
July 1, 1886, amount available	4,434 45

(See Appendix M 14.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF FLORIDA.

Officers in charge, Capt. William T. Rossell, Corps of Engineers, to April 26, 1886, since which date Lieut. William M. Black, Corps of Engineers.

1. *Saint John's River, Florida.*—Operations for the improvement of the channel over the bar at the mouth of this river were carried on from July 1 to September 23, 1885, in conformity with the plan submitted by the Engineer officer in charge June 30, 1879.

The plan consists essentially in the construction of two low jetties starting, respectively, from the opposite shores of the entrance and so directed that the outer ends on the bar will be approximately parallel and 1,600 or 1,800 feet apart. By means of these works it is expected to maintain a practicable low-river depth of 15 feet upon the bar, where previously the navigable low-water depth had not usually exceeded 6 to 7 feet.

Prior to July 1, 1885, the south jetty had a total length of 6,715.4 feet. It consisted for the greater part of this length of but one course of mattresses, covered with from 12 to 15 inches of stone. Along one portion of the jetty seven additional courses of mattresses had to be added. To deflect the rapid current formed along the jetty eight low spur jetties of two courses of mattresses covered with stone were constructed, four on each side of the main jetty and opposite to each other. The jetty as first constructed proved too narrow and had to be widened. Accordingly, in all of the later foundation mattresses placed the width was increased to from 110 to 120 feet.

The north jetty had a total length of 2,617.5 feet, and was composed of a single course of mattresses, covered with from 9 inches to 12 inches of stone.

On July 1, 1885, a 6-foot channel 400 feet wide had formed across the bar between the ends of the jetties.

During the past fiscal year work was continued until September 23; 28.93 cubic yards of stone were placed on the south jetty.

The north jetty was extended.

At the close of the fiscal year 1885-'86, the total length of the south jetty was 6,715.4 feet. The north jetty had a total length of 4,330.7 feet.

The total appropriations to date amount to $525,000; the total expenditures to $523,065.72.

A channel 400 feet wide, 8 feet deep, with a mid-channel depth of 8.8 feet at mean low water, has opened across the bar between the jetties. This has been the ship entrance since March, 1886.

With the balance available and the appropriation asked for it is proposed to continue operations under the approved project.

July 1, 1885, amount available		$30,925 95
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$28,339 33	
July 1, 1886, outstanding liabilities	652 34	
		28,991 67
July 1, 1886, amount available		1,934 28
Amount appropriated by act approved August 5, 1886		150,000 00
Amount available for fiscal year ending June 30, 1887		151,934 28
Amount (estimated) required for completion of existing project		631,409 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		300,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix N 1.

2. *Upper Saint John's River, Florida.*—By the river and harbor act of July 5, 1884, the sum of $5,000 was appropriated for improving the Upper Saint John's River, Florida, this being the first appropriation made for this work.

The part of the Saint John's River referred to in the act extends from Lake Monroe to the head of Lake George, a distance of 45 miles. The stream has sufficient depth for the class of vessels adapted to navigate the Upper Saint John's, but is very crooked.

The Engineer officer then in charge—October 5, 1883—recommended to confine the work of improvement to the most prominent bends, establishing a straighter channel by suitable cut-offs, to be made 6 feet deep at low-river stage, and 100 feet wide at the bottom. Two estimates were submitted, one for straight cut-offs, at a cost of $43,000, and one for curved cut-offs, at a cost of $38,800.

The work consists chiefly in dredging, but some light closure dams and some grubbing will also be required.

The work was advertised, but no bids were received, on account of the small sum appropriated, and operations have been deferred until further appropriations are made.

The balance available and the appropriation asked for are to be used in accordance with the approved project.

July 1, 1885, amount available	$4,979 21
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4 05
July 1, 1886, amount available	4,975 16
Amount (estimated) required for completion of existing project	33,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 2.)

3. *Volusia Bar, Florida.*—Operations have been carried on here at intervals since December, 1880, in conformity to the project submitted July 16, 1879, and revised in 1882 and 1883.

The plan of improvement comprises the construction of two converging brush-and-stone jetties, with a view to establishing and maintaining a channel 6 feet deep over this bar, where the minimum low-water depth had been from 3½ to 4 feet. The estimated cost of the revised project was $25,000.

The west jetty now is 2,206 feet long. It is generally formed of a single course of brush mattresses from 6 to 12 feet wide covered with broken stone. At its outer end there is a second course 6 feet wide and 159 feet long.

The east jetty is 3,459 feet long. Its construction is similar to that of the west jetty. The second course of mattress at its outer end is 247 feet long. At their shore ends the jetties are 2,400 feet apart. On the bar the jetties are 240 feet apart, and parallel. Clusters of piles securely fastened with chains were driven in two rows, 100 feet apart, parallel to the west jetty.

The appropriations for this improvement have aggregated $17,500. The total expenditures to June 30, 1885, were $17,337.51, and have resulted in forming and maintaining a channel between the jetties having a least depth of 5¾ feet and a width of about 70 feet.

No operations were carried on here during the past fiscal year, owing to a lack of funds. An examination made in June, 1886, showed the channel as above; 121 out of the 158 piles driven are still standing.

The balance available is to be used in accordance with the project.

July 1, 1885, amount available		$162 49
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2 75	
July 1, 1886, outstanding liabilities	12 00	
		14 75
July 1, 1886, amount available		147 74
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,647 74

(See Appendix N 3.)

4. *Tampa Bay, Florida.*—The harbor of Tampa, at the head of this bay, was separated from deep water by a flat 2 miles wide. Through this was a narrow channel with an available depth of about 5 feet, formed by the waters of the Hillsborough River.

The present project was adopted in 1880, and has for its object the formation of a 9-foot channel from the 9-foot curve in the bay to the wharves of Tampa, in Hillsborough River, 150 feet wide through the bay and 200 feet wide in the river, at an estimated cost of $97,000.

Up to June 30, 1885, $47,801.50 had been expended, resulting in a somewhat narrow 9-foot channel from the mouth of the river to deep water in the bay. This was obstructed by several shoals, having only 7½ feet of water.

Work was continued from the beginning of the fiscal year to August 15, under a contract for dredging and rock excavation, and was then stopped by the near exhaustion of the appropriation. When work ceased there was a 9-foot channel 4,793 feet long and from 45 to 150 feet wide from deep water in the river toward the bay. An examination made in May, 1886, showed its center line but little changed.

To complete the present project, the original estimate must be increased on account of extra labor due to the deterioration of the dredged cut in the intervals between appropriations. Without auxiliary works there is but little hope of permanency in the dredged channel.

July 1, 1885, amount available	$12,198 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,368 04
July 1, 1886, amount available	830 46
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,830 46
Amount (estimated) required for completion of existing project	63,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 4.)

5. *Apalachicola Bay, Florida.*—The present project for this improvement was adopted in 1880, the object being to afford a channel of entrance from Apalachicola Bay into Apalachicola River up to the wharves of the city of Apalachicola, 100 feet wide and 11 feet deep at mean low water. Before the improvement was begun the channel had an available depth of 3½ feet.

The amount expended to June 30, 1885, is $54,284.37, and has resulted in giving a channel of 60 feet in width and 6.5 feet depth through the bar.

The results have not been satisfactory. In previous reports doubts have been expressed as to the permanency of the dredged channel unless it could be fully cut through at one time. The limited appropriations heretofore made have not permitted this to be done. It is believed that the desired channel cannot be maintained without the aid of auxiliary works.

On account of the continued shoaling of the dredged channel the estimate for the original project must be increased by $23,000.

No appropriation having been made, and the balance available having been small, no work was done during the past fiscal year.

The balance available and appropriation asked for are to be expended in accordance with the approved project.

July 1, 1885, amount available	$715 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	18 90
July 1, 1886, amount available	696 73
Amount appropriated by act approved August 5, 1886	12,000 00
Amount available for fiscal year ending June 30, 1887	12,696 73

Amount (estimated) required for completion of existing project	$56,696 73
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 5.)

6. *Suwanee River, Florida.*—The present project for the improvement of this river was adopted in 1880. Its object is to make a channel 150 feet wide and 5 feet deep at mean low water from the Gulf through the east and west passes into the river and as far up as Roland's Bluff. From there to Ellaville the channel is to be 60 feet wide and 4 feet deep. Before the improvement there was a depth of 3 feet on the bar and of 1½ feet in the river above Roland's Bluff. Above its mouth the river is much obstructed with snags and overhanging trees.

The amount expended up to June 30, 1885, is $15,683.76, and has given a dredged channel 4,429 feet long, 60 feet wide, and 5 feet deep from the river partly across the bar at the east pass.

During the past fiscal year operations were continued there. Four thousand five hundred and eighty-two cubic yards of material were dredged, increasing the length of channel to 5,835 feet. To complete this channel an additional distance of 9,765 feet must be dredged, where there is an average depth of 3½ feet.

The balance available and the appropriation asked for will be applied to continuing work under the present project.

July 1, 1885, amount available	$2,316 24
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,256 24
July 1, 1886, amount available	60 00
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,060 00

Amount (estimated) required for completion of existing project	32,158 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 6.)

7. *Key West Harbor, Florida.*—The present project for the improvement of this harbor was adopted in 1882, the object being to afford a channel of entrance from the Gulf of Mexico into the northwest channel to Key West, so as to give a depth of 17 feet at mean low water.

The principal object to be gained by this improvement is in the great saving in distance for all vessels plying between Key West and the Gulf ports.

The amount expended to June 30, 1885, is $25,000, and has resulted in cutting a channel entirely through the bar 60 feet in width at the bottom and 65 feet at the top, with a depth of 15 feet at mean low water.

From the soundings taken on the mail steamer using this channel it is believed that this cut has filled and that there now exists a channelway with only an available depth of 11 feet at mean low water.

Amount appropriated by act approved August 5, 1886	$2,500 00

Amount (estimated) required for completion of existing project	115,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 7.)

8. *Pease Creek, Florida.*—The project for the improvement of this stream, adopted in 1881, is to improve it for high-water navigation by the removal of snags, overhanging trees, and loose rocks from the channel from its mouth up to Fort Meade.

The amount expended to June 30, 1885, is $10,453.18, and has resulted in the improvement of about 64 miles of the river from its mouth upstream.

During the past fiscal year nothing has been done except caring for the public property, the small balance available rendering any work impossible.

Before the improvement the stream was of generally sufficient width and depth, but was much obstructed.

The balance available is to be applied to the care and preservation of the public property, and to the continuation of the work under the approved project.

July 1, 1885, amount available		$546 82
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$32 75	
July 1, 1886, outstanding liabilities	30 00	
		62 75
July 1, 1886, amount available		484 07
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,484 07

(See Appendix N 8.)

9. *Harbor at Cedar Keys, Florida.*—The present project for the improvement of this harbor was adopted in 1884. It consists in cutting a channel, by dredging and rock excavation, 200 feet wide and 10½ feet deep at mean low water, through the Middle Ground. By act approved July 5, 1884, an appropriation of $5,000 was made to carry on this work, the only appropriation under this project.

Under a former project a cut 11½ feet deep was made through the Middle Ground. This is gradually shoaling.

No work was done on the present project prior to June 30, 1885. Since then dredging and rock excavation were carried on in the shoal near Buoy No. 12; .370 cubic yards of sand and 615 cubic yards of rock were removed, making a channel 11 feet deep and from 30 to 60 feet wide almost through the shoal when the appropriation was exhausted. This cut has retained its depth.

The appropriation asked for is to be used in accordance with the present project.

July 1, 1885, amount available	$4,802 55
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,802 55
Amount appropriated by act approved August 5, 1886	7,000 00
Amount (estimated) required for completion of existing project	13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	13,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 9.)

10. *Manatee River, Florida.*—The present project for the improvement of this river was adopted in 1882, the object being to afford a channel of entrance from Tampa Bay into Manatee River, so as to give a depth of 13 feet at mean low water from Tampa Bay up the river to Shaw's

Amount (estimated) required for completion of existing project	$56,696 73
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 5.)

6. *Suwanee River, Florida.*—The present project for the improvement of this river was adopted in 1880. Its object is to make a channel 150 feet wide and 5 feet deep at mean low water from the Gulf through the east and west passes into the river and as far up as Roland's Bluff. From there to Ellaville the channel is to be 60 feet wide and 4 feet deep. Before the improvement there was a depth of 3 feet on the bar and of 1½ feet in the river above Roland's Bluff. Above its mouth the river is much obstructed with snags and overhanging trees.

The amount expended up to June 30, 1885, is $15,683.76, and has given a dredged channel 4,429 feet long, 60 feet wide, and 5 feet deep from the river partly across the bar at the east pass.

During the past fiscal year operations were continued there. Four thousand five hundred and eighty-two cubic yards of material were dredged, increasing the length of channel to 5,835 feet. To complete this channel an additional distance of 9,765 feet must be dredged, where there is an average depth of 3½ feet.

The balance available and the appropriation asked for will be applied to continuing work under the present project.

July 1, 1885, amount available	$2,316 24
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,256 24
July 1, 1886, amount available	60 00
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,060 00

Amount (estimated) required for completion of existing project	32,158 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 6.)

7. *Key West Harbor, Florida.*—The present project for the improvement of this harbor was adopted in 1882, the object being to afford a channel of entrance from the Gulf of Mexico into the northwest channel to Key West, so as to give a depth of 17 feet at mean low water.

The principal object to be gained by this improvement is in the great saving in distance for all vessels plying between Key West and the Gulf ports.

The amount expended to June 30, 1885, is $25,000, and has resulted in cutting a channel entirely through the bar 60 feet in width at the bottom and 65 feet at the top, with a depth of 15 feet at mean low water.

From the soundings taken on the mail steamer using this channel it is believed that this cut has filled and that there now exists a channelway with only an available depth of 11 feet at mean low water.

Amount appropriated by act approved August 5, 1886	$2,500 00

Amount (estimated) required for completion of existing project	115,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 7.)

8. *Pease Creek, Florida.*—The project for the improvement of this stream, adopted in 1881, is to improve it for high-water navigation by the removal of snags, overhanging trees, and loose rocks from the channel from its mouth up to Fort Meade.

The amount expended to June 30, 1885, is $10,453.18, and has resulted in the improvement of about 64 miles of the river from its mouth upstream.

During the past fiscal year nothing has been done except caring for the public property, the small balance available rendering any work impossible.

Before the improvement the stream was of generally sufficient width and depth, but was much obstructed.

The balance available is to be applied to the care and preservation of the public property, and to the continuation of the work under the approved project.

July 1, 1885, amount available		$546 82
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$32 75	
July 1, 1886, outstanding liabilities	30 00	
		62 75
July 1, 1886, amount available		484 07
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,484 07

(See Appendix N 8.)

9. *Harbor at Cedar Keys, Florida.*—The present project for the improvement of this harbor was adopted in 1884. It consists in cutting a channel, by dredging and rock excavation, 200 feet wide and 10½ feet deep at mean low water, through the Middle Ground. By act approved July 5, 1884, an appropriation of $5,000 was made to carry on this work, the only appropriation under this project.

Under a former project a cut 11½ feet deep was made through the Middle Ground. This is gradually shoaling.

No work was done on the present project prior to June 30, 1885. Since then dredging and rock excavation were carried on in the shoal near Buoy No. 12; 370 cubic yards of sand and 615 cubic yards of rock were removed, making a channel 11 feet deep and from 30 to 60 feet wide almost through the shoal when the appropriation was exhausted. This cut has retained its depth.

The appropriation asked for is to be used in accordance with the present project.

July 1, 1885, amount available	$4,802 55
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,802 55
Amount appropriated by act approved August 5, 1886	7,000 00
Amount (estimated) required for completion of existing project	13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	13,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 9.)

10. *Manatee River, Florida.*—The present project for the improvement of this river was adopted in 1882, the object being to afford a channel of entrance from Tampa Bay into Manatee River, so as to give a depth of 13 feet at mean low water from Tampa Bay up the river to Shaw's

and McNiel's points. The least depth on the bar at the river before the improvement was 8 feet at mean low water, not sufficient for the class of vessels engaged in the commerce between the river and outside ports.

The amount expended to June 30, 1885, is $12,000, and has resulted in securing a channel 2,150 feet in length, 1,750 feet of which has a depth of 12½ feet and a width of 60 feet, and 400 feet has a depth of 11½ feet and width of 35 feet through the bar at the entrance of the river from Tampa Bay.

There being no funds available, no work has been done during the past fiscal year.

The appropriation asked for is to be applied to continuing the improvement in accordance with the project, extending, widening, and deepening the cut by dredging.

Amount appropriated by act approved August 5, 1886	$8,000 00
Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1886 and 1867.	

(See Appendix N 10.)

11. *Caloosahatchie River, Florida.*—The present project for the improvement of this river was adopted in 1882, the object being to so improve the river from the bar at the mouth up to Fort Meyers as to accommodate vessels of 6 feet draught.

The amount expended up to June 30, 1885, is $5,544.71, and has resulted in improving the bar at the mouth of the river, giving a channel depth of 9 feet at mean low water, where there was only 5½ feet before.

During the past fiscal year dredging was continued in the vicinity of Jew Fish Bayou. At the close of operations there was a clear channel of the required width and depth from the mouth to Fort Meyers.

No further appropriation is needed. The balance available will be used in maintaining and caring for the work.

July 1, 1885, amount available	$4,455 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,911 88
July 1, 1886, amount available	543 41
Amount appropriated by act approved August 5, 1886	4,000 00
Amount available for fiscal year ending June 30, 1887	4,543 41

(See Appendix N 11.)

12. *Appalachicola River, Florida.*—The project for the improvement of this river was adopted in 1874, the object being to afford a channel of 6 feet depth and 100 feet navigable width its whole length, avoiding the worst portions by utilizing Styx River and Moccasin Slough. The channel at that time had sufficient depth and generally sufficient width, but was obstructed by snags and overhanging trees, but the portion through Moccasin Slough was narrow, crooked, and difficult.

The amount expended to June 30, 1886, is $39,383.22, and has resulted in the complete execution of the project, and, in addition, the opening of Chipola Cut-off to White's Bluff, a distance of 9 miles, the widening of the canal at Moccasin Slough, and the removal from the river of the yearly accumulation of snags, logs, and sunken timber.

During the past fiscal year operations were limited to clearing about one mile of the channel above Moccasin Slough.

The amount available and the appropriation asked for are to be applied to maintaining the improvement as completed.

July 1, 1885, amount available		$2,255 49
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,072 81	
July 1, 1886, outstanding liabilities	65 90	
		2,138 71
July 1, 1886, amount available		116 78
Amount appropriated by act approved August 5, 1886		1,000 00
Amount available for fiscal year ending June 30, 1887		1,116 78

Amount (estimated) required for preservation of improvement annually	2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	2,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 12.)

13. *Withlacoochee River, Florida.*—The project for this improvement, adopted in 1881, is to improve the river by the removal of snags, loose rocks, and overhanging trees, and by deepening a bar at the mouth of the river and some of the worst shoals, so as to enable boats drawing two feet of water to navigate the river during about half the year.

The amount expended to June 30, 1885, is $10,071.20, and has resulted in improving the river from its mouth to Lake Panasofkee. In many places, however, along the route the width and depth are insufficient (being 20 feet and 2 feet respectively) and must be increased.

No work was done during the past fiscal year beyond caring for the public property.

The balance available and the appropriation asked for are to be expended in accordance with the project.

July 1, 1885, amount available	$428 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	272 00
July 1, 1886, amount available	156 80
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,156 80

Amount (estimated) required for completion of existing project	10,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,400 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 13.)

14. *Removing sunken vessels or craft obstructing or endangering navigation.*—*Wreck of the steamer Dictator.*—A contract, approved December 8, 1885, was made for the removal of this wreck from the harbor at Tampa, Fla. After some work had been done the contractors disagreed and the contract had to be annulled. Proposals for its removal were again asked for, and a contract is now being made with the lowest bidders.

Removal of sunken scow from harbor at Tampa, Florida.—Public notice, according to law, was given to persons interested in this boat. No answer having been received, a contract for its removal was duly entered into. The work was reported finished on May 17, 1886.

(See Appendix N 14.)

bars. Good channels were obtained for about nine months in the year, that on the Oostenaula having a depth of 3 feet, and on the Coosawattee a depth of 2 feet of water. No commercial necessity exists for any further appropriations for these rivers at present.

July 1, 1885, amount available		$1,163 71
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$20 00	
July 1, 1886, outstanding liabilities	21 85	
		41 85
July 1, 1886, amount available		1,121 86

(See Appendix O 4.)

5. *Coosa River, Georgia and Alabama.*—A plan was adopted in 1875 to provide a channel, not less than 80 feet wide and 3 feet deep at low water, between Rome and Greensport, and the improvement of the shoals and reefs below Greensport by channel excavation and locks and dams.

The expenditure up to June 30, 1886, of $417,896.06 has resulted in securing a fair navigable channel from Rome to Greensport.

During the past fiscal year, with the limited appropriation available, the work of quarrying and dressing stone for the locks and dams at Ten Island Shoals was continued.

The funds available and the appropriation asked for can be profitably expended in continuing the construction of locks and dams below Greensport and the removal of obstructions from the river channel.

July 1, 1885, amount available		$21,862 12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$21,058 18	
July 1, 1886, outstanding liabilities	1,254 41	
		22,312 59
Amount appropriated by act approved August 5, 1886		45,000 00

Amount (estimated) required for completion of existing project	96,968 00
Amount that can be profitably expended in fiscal year ending June 30, 1888. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	97,000 00

(See Appendix O 5.)

6. *Chattahoochee River, Georgia and Alabama.*—The present plan of improvement (adopted in 1873) contemplates a low-water channel, 4 feet in depth and 100 feet in width, from Columbus, Ga., to Chattahoochee, Fla., a distance of 223 miles, by the removal of snags and other obstructions from the channel, overhanging trees from the banks; by cutting a channel through the rock shoals, and deepening sand-bars by scour.

The expenditure up to the present time of $188,857.40 has resulted in securing a fair, navigable channel between Chattahoochee and Eufaula at all seasons of the year, and between Eufaula and Columbus at all times except during the prevalence of extreme low water.

During the past fiscal year the principal work done has been the excavation of a channel through a portion of Uchee Shoals, removing 4,473 cubic yards of rock. A new steam snag-boat has been completed and equipped for work on this river.

The amount available and the appropriation asked for are to be applied to continuing the removal of obstructions from the river channel.

July 1, 1885, amount available		$30,755 65
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$16,594 08	
July 1, 1886, outstanding liabilities	5,095 87	
		21,689 95
July 1, 1886, amount available		9,065 70
Amount appropriated by act approved August 5, 1886		20,000 00
Amount avilable for fiscal year ending June 30, 1887		29,065 70
Amount (estimated) required for completion of existing project		162,228 69
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 6.)

7. *Alabama River, Alabama.*—The plan of improvement for the Alabama River, adopted in 1876, contemplates a channel, 200 feet in width and 4 feet in depth at low water, from its mouth, 50 miles above Mobile, Ala., to Wetumpka, Ala., a distance of 323 miles. Before the improvement was commenced the channel had a least depth of about 2 feet on some of the shoals, and was badly obstructed by snags and overhanging trees.

The expenditure up to June 30, 1886, of $129,714.12 has resulted in rendering that part of the river below Montgomery easy of navigation during ordinary low water.

During the past fiscal year the snag-boat belonging to this improvement was kept at work, while the appropriation held out, in removing snags and other obstructions from the channel, and at one point on the river works of contraction were put in for deepening the channel. The amount available and the appropriation asked for are to be applied to continuing the work of improvement in accordance with the adopted plan, and maintaining the work already done.

July 1, 1885, amount available		$6,003 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,717 88	
July 1, 1886, outstanding liabilities	65 75	
		5,783 63
July 1, 1886, amount available		220 13
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		15,220 13
Amount (estimated) required for completion of existing project		84,741 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 7.)

8. *Tallapoosa River, Alabama.*—The plan of improvement adopted pursuant to an examination and partial survey of this river, made by an act of Congress approved June 14, 1880, contemplates obtaining a navigable channel from the mouth of the river to the foot of Tallassee Reefs, 2 miles below the town of Tallassee, a distance of 48 miles, with a least depth of 3 feet and width of 60 feet at low water. This is to be accomplished by the removal of snags, logs, &c., from the channel; cutting overhanging trees from the banks; cutting the prescribed channel through the rock-reefs, and the removal of bars by works of contraction.

The expenditure up to June 30, 1886, of $23,441.46 has resulted in the partial improvement of the channel in the lower portion of this river, but the work has not progressed sufficiently to affect navigation.

During the past fiscal year about 12½ miles of this river was cleared of snags, logs, and overhanging trees.

The amount available and the appropriation asked for are to be applied to continuing the work of improvement of the river in accordance with the approved plan; removing obstructions from the channel, blasting through rock-reefs, and deepening the channel over movable bars by works of contraction.

July 1, 1885, amount available		$7,098 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,522 26	
July 1, 1886, outstanding liabilities	45 00	
		5,567 26
July 1, 1886, amount available		1,531 54
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		9,031 54
Amount (estimated) required for continuing existing project		15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		15,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix O 8).

9. *Cahaba River, Alabama.*—The plan of improvement adopted in 1883 contemplates a channel 60 feet in width and 3 feet in depth at low water from its mouth to the town of Centreville, a distance of 88 miles, by the removal of all obstructions from the channel, cutting through rock-reefs, scouring bars, and cutting overhanging trees.

The expenditure up to June 30, 1886, of $28,989.79, has resulted in the partial improvement of the river from its mouth to Centreville, adapting it to high-water navigation. This is within a distance of 21 miles of Cane Creek, which is near the Cahaba coal fields. For this section of the river, lock and dam navigation is proposed.

During the past fiscal year about 19½ miles of the river was cleared of snags, logs, and overhanging trees.

The funds available and the appropriation asked for are to be applied to continuing the work of improvement, in accordance with the approved plan; removing obstructions from the channel, blasting through rock-reefs, and deepening the channel over movable bars by works of contraction.

July 1, 1885, amount available		$5,197 97
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,187 76	
July 1, 1886, outstanding liabilities	49 50	
		4,237 26
July 1, 1886, amount available		960 71
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		8,460 71
Amount (estimated) required for completion of existing project		157,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix O 9.)

10. *Conecuh-Escambia River, Florida and Alabama.*—The plan of improvement for this river, adopted pursuant to partial examinations and surveys made in 1878–'79, contemplates the removal of snags and sunken logs and other obstructions from the channel, closing cut-offs, and cutting through rock-shoals from the mouth of the river, in Pensacola Bay, to Indian Creek, a distance of 273 miles, for the purpose of facilitating the movement of logs and rafts down the river, affording at the same time facilities for steamboat navigation.

The expenditure up to June 30, 1886, of $38,953.64, has resulted in dredging a channel through the bar at the mouth of the river, and in the removal of obstructions to navigation, so that at the present time the river is navigable at ordinary stages for steamboats drawing 5½ feet of water from Ferry Pass to Skinner's Landing, a distance of 17 miles, and for boats drawing 3 feet to the Alabama State line.

During the past fiscal year about 11,000 logs, snags, and overhanging trees were removed from this river, together with a small amount of rock from the channel.

The amount available and the appropriation asked for are to be applied to the continuation of the work of river improvement in accordance with the approved plan; removing obstructions from the channel, blasting through rock-reefs, and deepening the channel over movable bars by works of contraction.

July 1, 1885, amount available		$9,296 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$8,195 87	
July 1, 1886, outstanding liabilities	34 50	
		8,230 37
July 1, 1886, amount available		1,065 85
Amount appropriated by act approved August 5, 1886		12,000 00
Amount available for fiscal year ending June 30, 1887		13,065 85

Amount (estimated) required for completion of existing project	35,376 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 10.)

11. *Choctawhatchee River, Florida and Alabama.*—The present plan of improvement was adopted in 1872 and modified in 1880, pursuant to an examination made under the act of March 3, 1879, and contemplates the improvement of the river from its mouth to Newton, a distance of 252 miles, so as to obtain a low-water navigable channel.

The expenditure up to June 30, 1886, of $71,645.95 has resulted in giving 4½ feet of water in the channel, except during low water, as far as Jones' old ferry, 27 miles above Geneva, and 2 feet of water in the channel as far as Pates Creek at a medium stage of water. During high water, 5 feet can be carried to this point.

During the past fiscal year, 8,787 snags, logs, and overhanging trees were removed from the river.

The funds remaining on hand and the appropriation asked for are to be applied to the further improvement of the river in accordance with the approved plan; removing obstructions from the channel, blasting through rock-reefs, and deepening the channel over movable bars by works of contraction.

July 1, 1885, amount available		$10,094 45
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,740 40	
July 1, 1886, outstanding liabilities	45 00	
		9,785 40
July 1, 1886, amount available		309 05
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		15,309 05

Amount (estimated) required for completion of existing project	35,832 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 11.)

12. *Lagrange Bayou, Florida.*—The plan of improvement adopted was made pursuant to an examination of this bayou in 1881, under an act of Congress approved March 3, 1881, and contemplates the deepening of the channel through the bayou so as to admit the passage of vessels drawing 4½ feet at mean low water, the work to be done by dredging.

Up to June 30, 1886, there has been expended on this work the sum of $2,000, allotted from the appropriation of $20,000 made by an act approved August 2, 1882, for the improvement of the Choctawhatchee River, Florida, the two improvements being closely related. The result has been to secure a channel 5 feet in depth at mean low water.

The appropriation asked for is to be applied to the widening of the channel and removing the remaining obstructions.

Amount appropriated by act approved August 5, 1886	$2,000 00

Amount (estimated) required for completion of existing project	3,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 12.)

13. *Harbor at Pensacola, Florida.*—The plan of improvement adopted in 1881 contemplates dredging a channel 300 feet wide and 24 feet deep at mean low water across the inner bar, for the temporary relief of the navigation of this harbor, and the preservation of the site of old Fort McRee by the construction of suitable works of shore protection, with a view to retaining this position for defensive purposes, and preventing further changes in the tidal currents through the continued abrasion of the shore at this point.

The expenditure up to June 30, 1886, of $192,223.99 resulted in obtaining a channel 120 feet in width and 24 feet in depth at mean low water across the shoal inside the bar, and in stopping the abrasion of the shore line at Fort McRee; but this channel was not maintained by the tidal currents, and on June 30, 1886, was 23 feet in depth at mean low water, a gain of 3.6 feet over the depth existing when the work was commenced.

An annual outlay will be necessary to maintain this dredged channel until the permanent improvement of this harbor shall have been authorized by Congress. The works of shore protection at the site of Fort McRee have been successful in stopping abrasion of the beach, advancing it 250 feet on the south side of the south jetty at this point, and advancing the 12, 18, and 24 foot curves of the western channel slopes fronting the shore-line at the same place.

During the past fiscal year works of shore protection at the site of Fort McRee were maintained by frequent repairs, and about 55,000 cubic yards of sand was dredged from the inner bar.

The amount available and the appropriation asked for will be expended in the completion of the works of shore protection, and of the dredging of the inner bar.

July 1, 1885, amount available		$31,800 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$29,024 28	
July 1, 1886, outstanding liabilities	330 00	
		29,354 28
July 1, 1886, amount available		2,446 01
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		22,446 01
Amount (estimated) required for completion of existing project		20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 13.)

IMPROVEMENT OF THE HARBOR OF MOBILE: OF WARRIOR, TOMBIGBEE, AND BLACK WARRIER RIVERS, ALABAMA, AND OF CERTAIN RIVERS IN MISSISSIPPI—IMPROVEMENT OF CHANNEL TO BILOXI BAY.

Officer in charge, Maj. A. N. Damrell, Corps of Engineers.

1. *Mobile Harbor, Alabama.*—The present project for the improvement of this harbor was adopted in March, 1880, the object being to afford a channel of entrance from the Gulf of Mexico to the city of Mobile of 200 feet width and not less than 17 feet depth at mean low water.

The channel before was 200 feet wide through Choctaw Pass Bar, with not more than 13 feet at the shoalest part, and was obtained by dredging under previous appropriations, from 1870 to 1878, inclusive, amounting to $401,000.

The amount expended to June 30, 1885, is $584,159.39, and resulted in obtaining a channel with a minimum width of 125 feet and a maximum width of 200 feet, a minimum depth of 16½ feet, and a maximum depth of 23 feet, from the 17-foot curve in Mobile River to the curve of same depth in the lower bay, a length of 26.33 miles.

The amount expended during the fiscal year ending June 30, 1886, is $74,927.83, and has resulted in increasing the minimum width of the above channel from 125 to 140 feet, its maximum width from 200 to 300 feet, and minimum depth from 16½ to 17½ feet.

The amount available and the appropriation asked for are to be applied to widening and deepening the channel, and it is expected the combined amounts will complete the project.

July 1, 1885, amount available	$75,840 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	74,927 83
July 1, 1886, amount available	912 78
Amount appropriated by act approved August 5, 1886	90,000 00
Amount available for fiscal year ending June 30, 1887	90,912 78
Amount (estimated) required for completion of existing project	80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	80,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 1.)

2. *Warrior and Tombigbee rivers, Alabama and Mississippi.*—(*a*) *Warrior River, Alabama.*—The present project for the improvement of this river was adopted in 1875, the object being to obtain a channel 4 feet deep and 80 feet wide at ordinary low water from its junction with the Tombigbee up to Tuscaloosa.

The channel at that time was not navigable at low water and was much obstructed at a medium stage.

The amount expended to June 30, 1885, was about $90,806.57 (exact figures cannot be given for the years 1875 to 1882, inclusive; the appropriation was made for the Warrior and Tombigbee jointly, without any specified allotment for each, and therefore no separate account was kept), and resulted in obtaining a channel safely and easily navigable at a stage of water fully 3 feet lower than was formerly practicable, enabling boats of 3 feet draught to run when the water was 1 foot above ordinary low water.

The amount expended during the fiscal year ending June 30, 1886, is $6,316.84, and resulted in removing snags from 38 miles of the river and the partial improvement of one of the bars.

The amount available and the appropriation asked for are to be expended in continuing the improvement according to project adopted, and will probably complete it.

July 1, 1885, amount available	$6,831 81
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,316 84
July 1, 1886, amount available	514 97
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	19,264 97
Amount (estimated) required for completion of existing project	34,714 62
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 2.)

(*b*) *Tombigbee River, from Fulton to Vienna.*—The project for the improvement of the river between Columbus and Fulton was adopted in 1873, the object being to give good high-water navigation throughout by the removal of snags and overhanging trees.

The channel before improvement was not navigable at all from Fulton down to Cotton Gin Port. From Cotton Gin Port down to Aberdeen, about 35 miles, it was navigable for small barges carrying about 125 bales of cotton. From Aberdeen to Columbus, about 65 miles, navigation was difficult when the river was 12 feet above ordinary low water.

The project for the improvement of the portion of the river between Columbus and Vienna was adopted in 1879, the object being to afford a channel of navigable width 3 feet deep during ordinary low water.

Before the improvement was commenced the channel was much obstructed by snags and overhanging trees, and there was only 1 foot of water on some of the bars during ordinary low water.

The amount expended to June 30, 1885, was $68,138.04, about (exact figures cannot be given for the reason mentioned in statement for Warrior River), and resulted in completion of the improvement projected for that section of the river from Fulton down to Columbus, and in giving such a channel from Columbus down to Vienna that navigation was possible on a 2-foot rise for boats drawing 3 feet, and the accomplishment of over one-half of the work projected.

The amount expended during the fiscal year ending June 30, 1886, is $3,788.98, and resulted in preservation of the improvement already obtained above Columbus and in the removal of snags and overhanging trees from Vienna up to within 5 miles of Pikerville, a distance of 38 miles, principally preservation of improvement already obtained.

The amount available and appropriation asked for are to be expended in continuing the improvement as projected, and it is expected will complete it.

July 1, 1885, amount available	$3,912 01
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,788 98
July 1, 1886, amount available	123 03
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,623 03
Amount (estimated) required for completion of existing project	6,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 2.)

(*c*) *Tombigbee River below Vienna.*—The project for the improvement of this portion of the river was adopted in 1879, the object being to afford a channel of navigable width and 4 feet deep at ordinary low water from the mouth up to Demopolis and 3 feet deep from Demopolis up to Vienna.

Before the improvement was commenced the river was navigable from the mouth up to Bladen Springs, 143 miles above Mobile, during the entire year, but was obstructed by snags. From Bladen Springs up to Demopolis, 243 miles above Mobile, navigation was suspended about two months yearly during low water.

From Demopolis up to Vienna the channel was much obstructed by snags and overhanging trees, and the water was so shoal on the bars that navigation was only attempted on a considerable rise. A railroad bridge at Jones's Bluff also gave considerable trouble.

The amount expended to June 30, 1885, was about $92,253.40 (exact figures cannot be given for reason given in report for Warrior River), and resulted in obtaining an unobstructed channel with 3 feet depth of water from the mouth up to Tompkins's Bluff, 197 miles above Mobile, with 2 feet depth up to Kirkpatricks, 260 miles above Mobile, and 1 foot depth (all at ordinary low water) up to Vienna.

The amount expended during the fiscal year ending June 30, 1886, is $2,341.47, and resulted in removing the logs and other obstructions that had accumulated during the last two years from Vienna 250 miles down stream, in preservation of improvement already obtained.

The amount available and the appropriation asked for are to be expended in continuing the improvement according to the project adopted, and will probably complete the improvement.

July 1, 1885, amount available	$3,058 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,341 47
July 1, 1886, amount available	716 70
Amount appropriated by act approved August 5, 1886	11,250 00
Amount available for fiscal year ending June 30, 1887	11,966 70

Amount (estimated) required for completion of existing project	$12,888 38
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,900 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 2.)

3. *Black Warrior River, from Tuscaloosa to Daniels Creek, Alabama.*—The present project for the improvement of this section of the river was adopted in 1886, the object being to afford a water-way for the transportation of coal in barges from the Warrior coal-fields to the Gulf of Mexico.

The present natural channel is only navigable during very high water, and is even then extremely dangerous.

The amount expended to June 30, 1885, was $2,978, and resulted in the completion of a survey for preparation of a project with plans and estimates.

The amount expended during fiscal year ending June 30, 1886, is $919.96, and has resulted in the adoption of a project and preparation of plans and estimates.

The amount available and appropriation asked for is to be applied to construction of locks and dams in accordance with the adopted project.

July 1, 1885, amount available	$47,022 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	919 96
July 1, 1886, amount available	46,102 04
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	102,352 04

Amount (estimated) required for completion of existing project	463,854 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	200,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 3.)

4. *Old Town Creek, Mississippi.*—The project for this improvement, adopted in 1883, is to improve this stream for high-water navigation by the removal of logs, snags, and overhanging trees from its mouth to City Point, a distance of 30 miles.

The amount expended to June 30, 1886, is $3,000, and has resulted in obtaining, by the removal of overhanging timber from the banks, logs and stumps from the bed of the river, a fair high-water channel from its mouth up to Camargo, 16 miles.

No work was done and no expenditure made during the fiscal year ending June 30, 1886.

The appropriation asked for is to be applied to continuing the improvement according to the approved plan by removing obstructions to high water navigation, working up stream toward City Point.

Amount (estimated) required for completion of existing project	$7,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 4.)

5. *Noxubee River, Mississippi.*—The present project for the improvement of this river was adopted in 1880, the object being to afford a channel for small river steamers from its mouth up to Macon, Miss., of navigable width and depth during about nine months of the year, or when the water is above the ordinary low-water stage.

The amount expended to June 30, 1885, was $34,114.60, and resulted in obtaining a channel partially improved, which has been used by steamboats the entire distance from the mouth of the river up to Macon, and a wholly improved channel (according to project) from Macon to a point 28 miles below, and from the mouth to a point 12 miles above, giving a river 40 miles wholly and 51½ miles partially improved.

The amount expended during the fiscal year ending June 30, 1886, is $3,222.89, and has resulted in wholly improving 15½ miles of the river, so that there is now 55½ miles of the river wholly improved and 36 miles partially improved.

The amount available and the appropriation asked for is to be applied to continuing the improvement in accordance with the project adopted, and it is thought this amount will complete the improvement.

July 1, 1885, amount available	$3,385 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,222 89
July 1, 1886, amount available	162 51
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,662 51
Amount (estimated) required for completion of existing project	20,245 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 5.)

6. *Pascagoula River, Mississippi.*—The present project for the improvement of this river was adopted in 1880, the object being to afford a channel 200 feet wide and 7 feet deep at mean low water from Mississippi Sound into East Pascagoula River, and to improve the river above by the removal of snags, overhanging trees, &c.

The channel before the commencement of the improvement had a depth of not more than 3 feet at mean low water at its shoalest place.

The amount expended to June 30, 1885, was $58,430.84, and resulted in securing a channel 180 to 190 feet wide and 7½ feet deep at mean low water from Mississippi Sound into Pascagoula River, and the thorough improvement of the river above for 50½ miles, and partially for 49 miles further up.

The amount expended during the fiscal year ending June 30, 1886, is $455.79, for watching and care of property, &c.

July 1, 1885, amount available	$569 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	455 79
July 1, 1886, amount available	113 37
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	20,113 37

(See Appendix P 6.)

7. *Harbor at Biloxi Bay, Mississippi.*—The amount appropriated by the river and harbor act of August 5, 1886, together with the money on hand heretofore appropriated, is directed by the act to be applied to deepening the channel from Mississippi Sound to the wharves at Biloxi.

July 1, 1885, amount available	$4,988 55
July 1, 1886, amount available	4,988 56
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	17,488 55

Amount (estimated) required for completion of proposed project	$37,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	37,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 7.)

8. *Horn Island Pass, Mississippi.*—No project has been adopted for the improvement of this locality, the amount appropriated being deemed insufficient for an economical prosecution of the work. It is possible that the increase in depth through this pass from natural causes will do away with the necessity for any expenditure to obtain the improvement desired.

The river and harbor act of August 5, 1886, directs that the balance on hand for this improvement be applied to the improvement of Pascagoula River.

July 1, 1885, amount available	$5,000 00
July 1, 1886, amount available	5,000 00

(See Appendix P 8.)

9. *Pearl River, Mississippi, below Jackson.*—The present project for the improvement of this portion of the river was adopted in 1880, the object being to obtain a channel 5 feet deep at ordinary low water, and of navigable width from the mouth of the river up to Jackson.

Before the improvement the river was not navigable at all at low water, and was difficult at high water.

The amount expended on the work to June 30, 1885, was $71,619.99, and resulted in considerable but incomplete improvement of the river for high-water navigation from Jackson to Poitevant's Bluff, a distance of 295 miles.

The amount expended during the fiscal year ending June 30, 1886, is $8,378.56, and resulted in considerable but incomplete improvement of that part of East Pearl River situated between the head of West Pearl River and the lower end of Home's Bayou, a distance of 20 miles.

Nothing has been done towards the improvement of the river below Home's Bayou to the mouth, about 20 miles.

The amount available and the appropriation asked for is to be expended in continuing the improvement, and will probably so improve the worst portions of this section, and the bar at the mouth of the river, as to meet the present demands of the commerce of the river.

July 1, 1885, amount available	$8,380 01
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,378 56
July 1, 1886, amount available	1 45
Amount appropriated by act approved August 5, 1886	13,125 00
Amount available for fiscal year ending June 30, 1887	13,126 45

Amount (estimated) required for completion of proposed modification of existing project	70,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 9.)

10. *Pearl River, Mississippi, from Jackson to Carthage.*—The present project for the improvement of this portion of the river was adopted in 1880, the object being to obtain a channel 5 feet deep and of navigable width throughout.

Before the improvement was commenced navigation was difficult even during high water on account of snags and overhanging trees.

The amount expended to June 30, 1885, was $18,447.60, and resulted in a material improvement of this section of the river.

The amount expended during the fiscal year ending June 30, 1886, is $52.40, and was expended in the care and preservation of the plant and property.

Boats of 3 feet draught of water can navigate the river from Carthage down, 12 miles, on a stage of 4 feet above low water, and the remaining distance to Jackson, 93 miles, on a rise of 6 feet.

The amount available, and the appropriation asked for, is to be applied to a continuation of the improvement according to the project, and will probably obtain a channel that can be navigated on a stage considerably lower than at present.

July 1, 1885, amount available	$52 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	52 40
Amount appropriated by act approved August 5, 1886	2,250 00
Amount (estimated) required for completion of existing project	29,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 10.)

11. *Pearl River, Mississippi, between Edinburg and Carthage.*—The project for the improvement of this portion of the river was adopted in 1884, the object being to obtain a good high-water channel throughout for the use of steamers during six or eight months of the year.

Before the improvement was commenced navigation was only possible during very high water, and was even then troublesome.

The amount expended to June 30, 1885, was $2,110.39, and resulted in such an improvement of over two-thirds of the distance as to permit of the passage of steamboats of 3½ feet draught, with comparative ease and safety, on a rise of 6 feet above ordinary low water.

The amount expended during the fiscal year ending June 30, 1886, is $389.61, and resulted in the improvement of the remaining one-third of the whole distance, so that boats of 3½ feet draught can navigate the river between Edinburg and Carthage, with comparative safety, on a rise of 6 feet above ordinary low water.

The amount available and the appropriation asked for is to be applied to continuing the improvement as projected, and it is thought that the amount will complete the work.

July 1, 1885, amount available	$389 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	389 06
July 1, 1886, amount available	55
Amount appropriated by act approved August 5, 1886	2,250 00
Amount available for fiscal year ending June 30, 1887	2,250 55
Amount (estimated) required for completion of existing project	10,964 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 11.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF JULY 5, 1884.

Major Damrell was charged with and completed the following, it appearing, after preliminary examinations, that the localities were worthy of improvement by the General Government:

1. *Pascagoula River, Mississippi,* from the mills at Moss Point down

to the anchorage in the bay, with a view to securing a uniform depth of 12 feet water.

Report transmitted to Congress and printed as House Ex. Doc. No. 83, Forty-ninth Congress, first session. (See also Appendix P 12.)

2. *Wacissa River, Florida.*—Report transmitted to Congress and printed as House Ex. Doc. No. 82, Forty-ninth Congress, first session. (See also Appendix P 13.)

INSPECTION OF THE IMPROVEMENT AT THE SOUTH PASS OF THE MISSISSIPPI RIVER.

Inspecting officer, Maj. W. H. Heuer, Corps of Engineers.

The inspecting officer in his annual report states that the full depths and widths of channels required by law have been maintained throughout the fiscal year ending June 30, 1886, except for seventeen days during January and February, when there was a deficiency in depth or width in the channel between the jetties. No dredging has been done on any part of the work since February, 1883.

The channel from the main river into the Gulf is in better condition, as regards width, depth, and navigability, than at the end of the previous fiscal year.

A complete survey of South Pass shows a channel having in the pass a least depth of 29.8 feet and the 26-foot channel was 300 feet wide.

In the jetties the average increase in depth of water during the year, as compared with the year previous, was about 5 feet.

Beyond the jetties the channel is 31.2 feet deep.

The 26-foot channel is 260 feet wide; the 30-foot channel is 190 feet wide. In the fan-shaped area beyond the jetties the scour and fill nearly balanced each other. The diagrams accompanying report show nearly all the scour to the eastward, and all of the deposit or fill to the westward of the ends of the jetties.

Attention is especially invited to that part of the report wherein Congress requires an inspecting officer "to report the depth of water and width of channel secured and maintained from time to time in said channel, together with such other information as the Secretary of War may direct."

The funds for this examination were exhausted at the end of November, 1885, the employés were seven months without pay, and continued work, voluntarily relieving the Government from any obligation unless Congress should appropriate funds for this purpose. The inspecting officer recommends that as the law requires these examinations and surveys, provision for making them in the way of an appropriation should be made an independent measure and not part of the river and harbor bill as heretofore.

July 1, 1885, amount available		$3,849 4
Amount appropriated by act approved May 26, 1886, to supply deficiency in amount required for expenditure to June 30, 1886		6,492 0
		10,341 4
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,119 92	
July 1, 1886, outstanding liabilities	49 02	
		9,168 9
July 1, 1886, amount available		1,172 5
Amount appropriated by act approved August 5, 1886		10,000 0
Amount available for fiscal year ending June 30, 1887		11,172 5

Amount that can be profitably expended in fiscal year ending June 30, 1888	$16,870 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q.)

IMPROVEMENT OF VARIOUS WATER-COURSES IN THE STATE OF LOUISIANA—IMPROVEMENT OF SABINE PASS AND OF SABINE AND NECHES RIVERS, TEXAS.

Officer in charge, Maj. W. H. Heuer, Corps of Engineers, with Lieut. O. T. Crosby, Corps of Engineers, under his immediate orders.

1. *Amite River, Louisiana.*—Before improvement the river was much obstructed by snags, sunken logs, and trees standing in the river. It was used, however, by a small steamer and some sailing vessels. In 1880 a project was made to improve the river by removing all obstructions and dredging above the Bayou Manchac as far as the appropriation would permit and get 5 feet depth of water. With the appropriation of $8,000, made in 1880, 40 miles of river improvement was done by contract; this proved very unsatisfactory, and was of but little benefit to navigation. In 1881 $5,000 was appropriated to continue the work. That under the first contract having been accepted in 1883, the project of improvement was modified so as to improve the river below Bayou Manchac by means of hired labor and Government plant. With this money about 8 miles of river was properly improved, the other 8 miles below this not yet having been touched. The original estimated cost of the work was $23,760, of which $13,000 has been appropriated and $12,878.01 spent.

To clear out the balance of the lower part of the river, as well as remove all other obstructions as far up as the mouth of the Cornite, beyond which it is thought inadvisable to improve the river, will cost $8,205.

The improvement has been beneficial to navigation, but it is not known that freight rates have been reduced, nor that commerce has been benefited to any extent by the money thus far spent. No money has been spent during the past year except to care for the plant.

The estimated amount required for completion of approved project, if appropriated, can be all expended in the fiscal year, and will be used in clearing out the stream, as indicated.

The improvement will not be permanent, as obstructions will re-form.

July 1, 1885, amount available	$121 99
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	120 00
July 1, 1886, amount available	1 99
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,001 99

Amount (estimated) required for completion of existing project	6,205 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R 1.)

2. *Tangipahoa River, Louisiana.*—Before improvement the river was obstructed by snags, logs, rafts, standing and overhanging trees. The project adopted in 1880 was to remove these obstructions as far up as Connor's Bridge, 53 miles above its mouth, and get all depth possible without dredging. The river was navigable for 34 miles of this distance for vessels of very light draught.

Congress has appropriated for the improvement of this river $11,000, and with this amount 41 miles of river were improved by contract work, which has been far from satisfactory.

The upper 7 miles of river worked over is now nearly as much obstructed as it was before work was commenced.

Total expended to June 30, 1884, $6,786.02.

During the fiscal year ending June 30, 1885, the Government plant, with hired labor, was sent to continue this work, and did effective work between Lanier's Bridge and the mouth. The upper 12 miles of the river has not been touched, and it seems useless to undertake to carry the improvement any further up-stream, as there does not seem to be any increase of commerce, and the obstructions form nearly as fast as they are removed. The original estimated cost of the improvement was $10,700, of which $9,000 have been appropriated and $9,000 spent.

Lumber and saw-logs are the principal products carried on the river. Should any further appropriations be made the money can be used in removing obstructions in the lower part of the river as they may form, but no recommendation for appropriation is made.

No work has been done during the past fiscal year, no appropriation having been made since that of July 5, 1884.

The river is not susceptible of permanent improvement.

Amount (estimated) required for completion of existing project $1,700 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix R 2.)

3. *Tchefuncte River, Louisiana.*—The river is navigable for steamers drawing 5 feet to Old Landing, about 10 or 12 miles above its mouth, and then for lighter draught schooners to Covington, about 2 miles further up on the Bogue Falia. The bar at the mouth of the river had a depth of 4½ feet on it at the lowest stage of the water. The project for the improvement of the river was made in 1880, and contemplated the removal of overhanging trees, logs, &c., in channel and the dredging of the bar at its mouth.

The obstructions, such as overhanging trees, logs in bed, &c., were removed, but the bar at the mouth was not dredged, as it would be likely to re-form. To prevent this, or retard its re-formation, the officer in charge in 1884 recommended the building of a breakwater extending into the lake for 2,500 feet and then dredging a channel through the bar.

With the two appropriations of $1,500 each, made in 1881 and 1882, the obstructions below Covington were removed; part of the unexpended balance was used for the construction of the breakwater extending 820 feet into the lake.

The original estimated cost of improving the river was $5,460, but this did not include the building of any breakwater across the bar. The project as modified in 1884 is estimated to cost $20,400. This has not yet received the sanction of Congress.

At the close of the fiscal year ending June 30, 1885, $3,000 had been expended on this improvement, at which time the navigation had been improved for schooners to Covington in consequence of removal of snags and overhanging trees, and it is thought that the breakwater has retarded the drift of sand on the bar at the river's mouth. For the year ending June 30, 1888, $19,000 can be expended in completing the work of improvement, and, if appropriated, it is proposed to extend the breakwater, dredge the bar, and remove any other obstructions that may have re-formed in the river since it was cleaned out.

The benefit to commerce is local. It is not known that there has been any increase to commerce in consequence of improvements thus far made. Should the improvements be made as contemplated, the mouth of the river would then become an excellent harbor of refuge for small vessels navigating the lake.

The report of 1884 gives commercial statistics of this river at $106,500, consisting of brick, sand, charcoal, wool, cotton, lumber, hides, beef, sugar, and molasses.

Amount (estimated) required for completion of existing project	$19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R 3.)

4. *Tickfaw River, Louisiana.*—The natural channel was much obstructed by snags and overhanging trees. The original project was adopted in 1881, the object being to obtain a channel of navigable width and depth for a distance of 26 miles up-stream. The amount expended to the close of the fiscal year ending June 30, 1883, is $2,004.64. The river was then navigable for 18½ miles for vessels drawing 4 feet.

The amount expended during the fiscal year ending June 30, 1884, is $1,955.14, for part payment of plant for Amite, Tickfaw, and Tchefuncte rivers, and for work resulting in the removal of all obstructions for a distance of 20 miles from the mouth, 18½ miles of which have been previously worked over by contract.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is $4,230, to be expended in carrying on the existing project, which will result in increasing the navigable length of the river.

No work was done during the past fiscal year.

July 1, 1885, amount available	$33 72
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	30 00
July 1, 1886, amount available	3 72
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,003 72

Amount (estimated) required for completion of existing project	4,230 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R 4.)

5. *Bayou Teche, Louisiana.*—The upper portion of this bayou from New Iberia to its head (80 miles), and especially from Saint Martinsville to its head (50 miles), was much obstructed by logs, trees, and snags. Below New Iberia considerable trouble was given by logs and snags. The project for its improvement contemplated the removal of these obstructions and the making of slackwater navigation by locks and dams. The original estimated cost was $135,625. Investigations as to cost of lock-construction, made in the light of recent work in other sections of the country, and made in much more detail than those first attempted, show that this estimate is much too small. (For full report of this matter, see Appendix R 5.) The lowest safe estimate is $175,000 for a lock and movable dam, to be placed about 60 miles below the head, and to

carry slackwater navigation to within about 20 miles. To this must be added the amount necessary for clearing the bayou of obstructions, which has now been appropriated, or at least very nearly this amount. The appropriations aggregate $32,500. With this, obstructions have been thoroughly removed from Franklin, near the mouth, to Leonville, 13 miles below the head, a total distance of about 100 miles, except for a few miles, from which only the most dangerous could be taken on account of approaching high water, and surveys have been made sufficient for presenting a plan of improvement. The funds on hand will probably suffice to carry the work to the head of the bayou, should that prove desirable, and to rectify any omission that work at comparatively high stages may have caused. Of the sum expended, nearly $6,000 covers a contract completed in June, 1881, under which work was done and accepted by an assistant engineer at such high stage as to be valueless. The effective work has been done during the last two fiscal years, and much benefit to navigation has resulted, but there has been little, if any, extension of commerce. The officer in charge, therefore, recommends that no large appropriation be made until it be seen whether the interests of commerce demand more than has been secured. As soon as the stage of water permits, further work may be prosecuted in the way of removal of obstructions until all has been done in this line that seems necessary. The winter and spring months of 1886–'87 will demonstrate whether any considerable use will be made of the improvement.

This matter will be watched and reported upon, probably in time for Congressional action upon appropriations for 1887–'88.

The railroad touching at numerous points on the bayou, in connection with its steamboats as feeders from the plantations to the railway stations, offers the short route to market for the products of the bayou and controls and carries nearly all the business of this section of the country.

July 1, 1885, amount available	$18,005 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	10,687 97
July 1, 1886, amount available	7,317 93

(See Appendix R 5.)

6. *Connecting Bayou Teche with Grand Lake at Charenton, Louisiana.*—The original project was adopted in 1880, the object being to connect Bayou Teche with Grand Lake at Charenton by the construction of a canal a little over a mile long, 50 feet wide, and 5 feet deep, with a lock at one end, estimated to cost $75,000.

This was modified by further study and examination, and it was found to cost no more to dig a canal 100 feet wide of same depth, on which no lock would be necessary. The latter is the more desirable project. The amount expended to date is $2,899.95, which was for examinations, surveys, and engineering and office expenses.

The officer in charge states that the work, if constructed, will be of local benefit only, will save 75 or 80 miles of transportation in logs and rafts, and that no advantage can be derived even by these until the completion of the canal. He therefore suggests that the work be not commenced until the amount necessary for its completion, viz, $75,000, is available.

No appropriation has been made by Congress since March 3, 1881.

July 1, 1885, amount available	$22,100 05
July 1, 1886, amount available	22,100 05

Amount (estimated) required for completion of existing project........ $53,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix R 6.)

7. *Bayou Black, Louisiana.*—An examination of this bayou was provided for by act of Congress 1880, a report of which, with plan and estimate, was published in the Report of the Chief of Engineers for 1881. In his report of 1881 Major Howell recommended the dredging of a channel 50 feet wide by 6 feet in depth from Tigerville to Houma, a distance of 24 miles and 4,000 feet, the estimated cost being $47,520. No level-line having been run, the depth of cut necessary to go 6 feet below tide-level was not known. An appropriation of $10,000 was made March 3, 1881. Authority was received for the transfer of dredge machinery from the charge of Major Mansfield to Major Howell. This machinery was put into a hull, the cost being borne by the appropriations for Bayous Black and Terrebonne and that part charged to Bayou Black was $4,708. A second appropriation of $10,000 was made August 2, 1882.

A line of levels run in 1883–'84 showed the bottom of the bayou at Houma to be 5½ feet above tide-level, this rise of 5½ feet occurring in the last 12 miles counted toward Houma. In his report of an examination of this bayou, made in April, 1885, by the officer in charge, he says "that there is no channel nor scarcely any water for the 14 or 15 miles of cut yet unopened; the bed of the bayou is filled with mud and obstructions, and that, owing to the softness of the mud, it may be necessary to build a timber revetment for a considerable portion of the route, to prevent the mud from running back into the cut."

The dredge-boat began work May 7, 1883, at Tigerville, and worked almost continuously until April 25, 1885, when it was stopped by the officer in charge on account of the smallness of the unexpended appropriation.

The original estimate for completing this improvement was $47,520. Of this amount nearly $25,000 has been expended, of which about $4,500 was used in part payment for the building of a dredge-boat. This would leave $20,000 expended in actual dredging of about 10 miles of bayou and between 14 and 15 miles yet to be dredged. The average quantity of material to be removed in each mile of cutting is estimated to be nearly double what it was in the preceding 10 miles already opened, and therefore is estimated to cost nearly twice as much, or $4,000 per mile. As there are yet 14 miles of cut to be made, the estimate for completing this cut should be fourteen times $4,000, equal to $56,000. This together with the $25,000 expended would be $81,000, an excess of $33,480 over the original estimate. It is barely possible that this estimate may be too great. But when the sunken imbedded logs, stumps, and roots thrown up by the dredge all along the embankment are seen, no prudent engineer would submit a smaller one. Nor is it likely that any contractor would make a contract to do the work required even on this estimate. Moreover, in pushing the work to advantage, the engineer in charge of this improvement has never estimated less than $10,000 to be necessary for any one year's work. On July 5, 1884, Congress appropriated $5,000. Such an amount enables a dredge and crew to work five or six months, then the funds become exhausted, and the balance of the year the dredge is laid up, and is deteriorating for want of use, in charge of a watchman, at considerable expense.

The products of adjacent plantations seem to vary in value, and aggregate from $300,000 to $500,000 per year, and consist ordinarily of about 7,000 hogsheads of sugar, 14,000 barrels of molasses, together with corn, rice, and other products. The freight on these at present is expensive, but the improvement of the bayou by inducing competition will possibly cause a reduction of freight charges and also an increase of the products. The improvement at best is simply a local one, and only benefits the people living on or near the bayou, and can in no wise be considered a public necessity. But as it has been begun by authority of Congress, and $25,000 has been expended on it, if the work were now stopped the greater portion of this money would be wasted. It is therefore assumed that the work will be continued to completion, and, in this event, that no less than $10,000 should be appropriated for the fiscal year ending June 30, 1888.

The dredge-boat belonging to this and the Bayou Terrebonne improvement was during the last fiscal year hired to a contractor for Government work on Red River. The sum of $2,330, received for hire, was applied to the Bayou Black appropriation, and almost entirely expended in repairing the dredge, which is now in fair condition.

July 1, 1885, amount available	$427 68
December 5 to 12, 1885, amount received for rent of dredge-boat	2,330 00
	2,757 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,325 87
July 1, 1886, amount available	431 81
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	56,000 00

(See Appendix R 7.)

8. *Bayou Courtableau, Louisiana.*—Examination was made in 1879. Estimated cost of improvement for bayou between Port Barre and Atchafalaya was $40,000.

The act of June 14, 1880, appropriated $7,500 to commence improvement, the project for which was to close some run-out bayous, with a view to confine the water in the Courtableau, and cause its current to wash out Little Devil Bar at its mouth. After this was accomplished, then to make slackwater navigation by means of locks and movable dams to Port Barre and above.

In 1883 this estimate was increased by $38,500, and provided for a masonry lock instead of a timber lock. This estimate, in so far as it applies to lock construction, is now known to be far too small. Careful estimates since made for Bayou Teche, when the conditions are similar to those existing on Bayou Courtableau, place the cost of one 10-foot lift-lock with movable dam at $175,000.

In 1882 some of the run-out bayous were closed by slashing trees, and one dam was built on the Big Fordoche; also one in the Little Fordoche. These cut the bar down 3 feet in two days. Sickness and high water materially interfered with properly pushing the work. In 1884 it was reported that the Little Fordoche dam had been cut by swampers and Little Devil Bar had shoaled 4 feet in vertical height.

During the past fiscal year the dams across the two Fordoche bayous were rebuilt. The work proved difficult and costly on account of an unexpected rise of the water and sickness of the workmen. The bar has now moved quite above Little Fordoche, which, when the dams were built, was at its head, and that part of Little Fordoche which is above the dam is now probably filled with sand. The high stage of the water at present prevents an examination.

Work was stopped during November, 1885; a considerable bill of lumber bought for the construction of another dam was stored and the quarter-boat laid up, funds having run too low to begin another—a third dam. In consequence of great floods in the Atchafalaya country, the other bayous running from the Courtableau have increased in size and will cost more to close than the original estimate.

The bayous must all be closed before any good results can be expected on Little Devil Bar and before any work should be attempted on the locks and dams.

The estimate for closing these bayous is $16,000.

July 1, 1885, amount available	$3,892 10
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,553 25
July 1, 1886, amount available	338 85
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,338 85
Amount (estimated) required for completion of existing project	11,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	11,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R 8.)

9. *Bayou Terrebonne, Louisiana.*—The natural low-water channel was much obstructed by shoals and sunken logs. The original project was adopted in 1880, the object being to obtain a depth of 4 feet with navigable width from Houma down to Gulf. The bayou is navigable for vessels of 5 feet draught as far as the improvement has been carried. Above that it is navigable to Houma, a distance of about 10, miles, for vessels of very light draught. No work has been done during past fiscal year. Freight rates have been reported considerably cheapened by the improvement.

The amount available and the appropriation asked for the next fiscal year will be applied to the continuation of the work towards Houma, and it is estimated will complete it to that point.

Amount appropriated by act approved August 5, 1886	$10,000 00
Amount (estimated) required for completion of existing project	3,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R 9.)

10. *Bayou La Fourche, Louisiana.*—The natural channel was much obstructed by snags, overhanging trees, shoals, and wrecks. The original project, adopted in 1879, had for its object the removal of these obstructions. The amount expended on this work up to end of fiscal year ending June 30, 1884, was $24,998.24. The amount expended during fiscal year ending June 30, 1885, was $3,756.21, for care of property, gauge-reading, and continuing improvement. Much relief has been given to commerce by removal of snags, &c. No permanent relief for the difficulties of low water over numerous shoals can be had save by some rather costly improvement, such as that by movable dams and locks. During the past fiscal year surveys were completed and plans and estimates submitted. The plan preferred by the engineer in charge is that for the canalizing the bayou, connecting it with the Mississippi

by a lock at its head. This improvement is estimated as costing $450,000, with $31,000 annual expense of maintenance; this including $22,500 interest on original cost, $450,000, at 5 per cent. The saving in freight obtainable by having steamboat navigation all the year round is estimated at $19,000. No indirect and indefinite benefits are here considered. Congress has not yet considered the advisability of undertaking this improvement.

July 1, 1885, amount available	$1,244 55
July 1, 1866, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	989 94
July 1, 1886, amount available	254 61

(See Appendix R 10.)

11. *Calcasieu River, Louisiana.*—The project made for the improvement in 1880 was to improve the river above the town of Lake Charles to Philip's Bluff by removing logs, snags, &c., at an estimated cost of $10,080, and then to dredge the bar at foot of Calcasieu Lake, at an estimated cost of $15,000 additional, making a total of $25,080.

In March, 1881, Congress appropriated $3,000 for improving this river from Philip's Bluff to its mouth; in August, 1882, appropriated $7,000 for improving Calcasieu River (no locality mentioned); and in July, 1884, appropriated $6,500 more without mentioning any locality.

Subsequent information was obtained showing that it was of far more importance to Government and all concerned to have the river improved below Lake Charles than above it, because the obstructions below interfered seriously with navigation, while those above did not. These obstructions below were a bar where the river enters Calcasieu Lake, and another much more serious one where the lake and Calcasieu Pass join, and finally the outer bar at the junction of the pass with the Gulf of Mexico. This second bar, that at the junction of the pass and lake, has been twice dredged through, under appropriations for improving Calcasieu Pass, but has again refilled. The estimated cost to cut a channel through this bar is $15,000, but it has not yet been decided that any money appropriated for Calcasieu River can be applied to removing this bar at the foot of Calcasieu Lake.

Until $15,000 becomes available for dredging a channel through this bar, it is useless to commence the work, and pending a decision from Congress as to whether this money can be used on this bar or other money becomes available, no work can be done. No part of this money has been spent as yet, except a small amount for the examination and surveys made.

NOTE.—The river and harbor act of August 5, 1886, directs that the money on hand heretofore appropriated for the improvement of Calcasieu River can be expended on Calcasieu Pass.

July 1, 1885, amount available	$16,255 46
July 1, 1886, amount available	16,255 46

(See Appendix R 11.)

12. *Calcasieu Pass, Louisiana.*—In 1874 a cut was dredged through the bar at the junction of the pass and Calcasieu Lake. This cut was 6,300 feet long, 60 feet wide, and 6 feet deep. The channel refilled in 1881-'82, was redredged by contract work to a depth of 8 feet by 7,500 feet long by 70 feet wide, and at a cost of $10,444. Information obtained in the fiscal year ending June 30, 1885, shows this cut to have again refilled to its original condition, about 3½ feet of depth.

In making these two dredged channels in 1874 and 1882 a demand was urgent to get immediate relief, and dredging was undoubtedly the quickest way to produce such results. As the appropriations were small, the cuts were made on the shortest line across the bar, which would require the least amount of excavation. The currents and seas passing from the lake into the pass, which were due generally to the prevailing winds in that particular section, did not, as a rule, follow the line of the cut, but moved diagonally across it, and to this, in a great measure, added to the small number of steamers plying through the cut, must be attributed the rapid refilling. It is possible that by changing the direction of any new cut to be made across the bar, so that the axis of the cut shall be in prolongation of the axis of the upper end of the pass, it may refill less rapidly than those formerly made; but a cut on this line will necessitate the removal of about 95,000 cubic yards of material, as compared with 75,000 on the old line. At all events, with the funds available ($2,925) nothing toward making a channel over the bar can be done unless the appropriation for the Calcasieu River, viz, $16,255.46, can be applied to this locality, and pending a decision on this point the work is practically tied up. If the Calcasieu River fund can be used for this purpose, then it is probable that a channel can be recut through the bar, and after this question has been decided it will be proper to make a determination of the best line to select for improvement.

It is thought that no improvement on this bar will be permanent. It is useless to make improvements elsewhere on this river until a channel is obtained over this bar. To dredge an effective channel 100 feet wide, 8 feet deep, over the bar will cost $16,500.

The commerce of the pass is about the same as that of the river, and estimated at $528,000 per year.

(See preceding note.)

July 1, 1885, amount available	$2,925 25
July 1, 1886, amount available	2,925 25

(See Appendix R 12.)

13. *Sabine Pass, Texas.*—Surveys made in 1853, 1872, 1873, 1881, and 1882 showed about 6½ feet of water over the bar at mean low tide. In 1876 and 1881 channels were dredged over the bar, but refilled. In 1882 a project was made for getting deeper water over this bar by means of two jetties, each about 4 miles long, extending from shore to beyond the outer crest of the bar. The improvement was estimated to cost $3,177,606.

In August, 1882, Congress appropriated $150,000 for this work. This and an unexpended balance from former appropriations made $300,000 with which to start the work. Contracts were made, and in 1883 a little over 3 miles of foundation of west jetty was laid and 1¼ miles of this jetty near shore were completed.

In July, 1884, Congress appropriated $200,000 for continuing the work. Work was continued by contract, and by June 30, 1885, 10,200 feet of the foundation of east jetty was laid, and 8,825 feet of this was built up to the level of mean high water.

During the past fiscal year work was continued until August 26, 1885, as far as the funds would permit. At this date the condition of the work was as follows:

East jetty foundation was 11,190 feet long. Ten thousand eight hundred and forty feet of this was built up nearly to the level of mean high tide.

The west jetty foundation was laid for a length of 16,074 feet, and 9,710 feet of this was raised above the level of mean high water.

Surveys made early in 1886 and one in June, 1886, show that the depth of water on the bar has increased to 8 feet at mean low water. A cyclone struck this work in June and destroyed about 6,000 feet of the top work of the jetties. The estimated damage to the work is about $23,000.

The officer in charge now reports the work as producing results in increasing the depth of water on the bar. If the portion of the jetties near the crest of the bar could be raised to or above the level of mean high water, and this is prevented in consequence of the want of funds, it is probable that very much better results would speedily be obtained. The injury to both jetties in the late cyclone may possibly also retard or prevent a further increase in depth on the bar, unless the injury can be repaired by further appropriation from Congress.

If this work is to be continued to completion, then, in an engineering point of view, the best results can be obtained by the expenditure of $1,000,000 per year.

The commerce of Sabine Pass is very little, and depends entirely on the completion of the work.

July 1, 1885, amount available	$107,902 46
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	105,256 10
July 1, 1886, amount available	2,646 36
Amount appropriated by act approved August 5, 1886	198,750 00
Amount available for fiscal year ending June 30, 1887	201,396 36
Amount (estimated) required for completion of existing project	2,298,604 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	500,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R 13.)

14. *Sabine River, Louisiana and Texas.*—At the commencement of the improvement of the river there was a depth of 3½ feet on the bar at its mouth, and also above the town of Orange. Logs, snags, &c., above here interfered with navigation.

In 1880 a channel 6 feet deep, 70 to 100 feet wide, was dredged through the bar. In 1881 several small cuts to avoid bends obstructed with logs were made above Orange. No work has been done since that date to June 30, 1885. Sixteen thousand five hundred dollars have been spent on the improvement of the river.

The dredged channel over the bar is somewhat obstructed by logs, but the depth is sufficient for present demands of navigation and commerce.

No material increase of commerce or navigation has resulted from the improvement made.

No work was done during the fiscal year ending June 30, 1886, and no appropriation is asked for the next fiscal year.

This river is not susceptible of permanent improvement.

July 1, 1885, amount available	$4,546 56
July 1, 1886, amount available	4,546 56

(See Appendix R 14.)

15. *Neches River, Texas.*—Before improvement of this river the bar at its mouth had 3 feet depth of water, and between Yellow Bluff and Bevilport navigation was interfered with by snags and fallen trees.

In 1879 a channel was dredged at the mouth of the river 5 feet deep and from 30 to 60 feet in width. In 1881 obstructions between Yellow Bluff and Bevilport were removed; $20,892.43 was expended in this improvement to June 30, 1884. During the past fiscal year the bar at mouth of river has been again surveyed, and shows a least depth of 3½ feet. To again deepen this channel to 5 feet would require the removal of 56,590 cubic yards of material, at an estimated cost of $16,977.

Condition of the improvement.—The depth of water on the bar at present seems to be ample to accommodate the limited commerce passing over it. Only one steamer uses it, and that only in doing Government work at Sabine Pass.

Sail-vessels cannot use the river below Beaumont without tow-boats, and there are no tow-boats in this stretch of river. This river is not susceptible to permanent improvement, and until commerce increases it is not deemed advisable at present to expend more money upon it.

No appropriation is asked for the next fiscal year.

July 1, 1885, amount available	$11,667 84
July 1, 1886, amount available	11,667 84

(See Appendix R 15.)

16. *Removal of sunken vessels or craft obstructing or endangering navigation.—Removal of wreck in harbor of New Orleans, Louisiana.*—After due advertisement a contract was made in 1884 for the removal of the wrecks of the steamships Gresham, Ailsa, and General Grant. The work was satisfactorily completed in December, 1885.

Amount expended during fiscal year ending June 30, 1886, $28,117.

(See Appendix R 16.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

Officer in charge, Major S. M. Mansfield, Corps of Engineers.

1. *Entrance to Galveston Harbor, Texas.*—The report of the Board of Engineers for Fortifications and for River and Harbor Improvements, mentioned in the last annual report, is appended to the report of the officer in charge, and will be found in Appendix S 1, herewith.

The Board estimates the amount required to carry completed jetties to the crest of the bar, with a view to obtaining a depth of 16 to 20 feet for navigation, at $3,000,000; to extend the jetties to the 30-foot curve, to obtain a 25 or 30 foot channel, $4,000,000 additional; total estimated to complete improvement, $7,000,000, providing the money is freely supplied.

The plan is in continuance of the project of 1880, and is designed to concentrate the outflowing currents upon a certain extent of bar to effect its removal and increase the depth of bar channel.

The amount expended prior to June 30, 1885, was $1,576,337.12 (including $100,000 of Galveston City funds), and was applied to works of improvement under the projects of 1874 and 1880.

The amount expended during fiscal year 1885–'86, $1,565.90, was applied to the examination, &c., of south jetty, required by the Board of Engineers.

The estimated amount required for the entire and permanent completion of the work of improvement, in accordance with the project of 1886, is $6,700,000.

One million dollars can be profitably expended in the fiscal year ending June 30, 1888, in jetty construction.

July 1, 1885, amount available		$1,662 88
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,565 90	
July 1, 1886, outstanding liabilities	84 78	
		1,650 68
July 1, 1886, amount available		12 20
Amount appropriated by act approved August 5, 1886		300,000 00
Amount available for fiscal year ending June 30, 1887		300,012 20

Amount (estimated) required for completion of existing project	6,700,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	1,000,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 1.)

2. *Ship-channel in Galveston Bay, Texas.*—The project of 1871 (modified in 1877) proposed the deepening and widening of the channel from the head of Bolivar Channel to the cut through Morgan's Point, to afford a channel of 12 feet depth at mean low tide, with a width at bottom of 100 feet. The natural channel had a depth of not more than 7 feet in the shoalest places.

The amount expended to June 30, 1886, $286,629.50, secured a navigable channel from the Gulf entrance to Morgan's Cut of 8.9 feet at mean low tide.

No work has been done since 1883, owing to the reserving of funds for Congressional action at first, and then afterwards and to the present time because of the provision in act of July 5, 1884, that the money in hand should not be expended until the Secretary of War be satisfied that the Buffalo Bayou Ship-Channel Company has relinquished or abandoned to the United States forever all its franchises and any and all right to collect or impose tolls or charges from any part of said ship-channel or Buffalo Bayou.

July 1, 1885, amount available	*$159,870 50
July 1, 1886, amount available	159,870 50

(See Appendix S 2.)

3. *Trinity River, Texas.*—The project of 1871 (modified in 1873) had for its object the opening of the river to navigation so as to admit the entrance of vessels drawing 5 feet. At the mouth of the river the natural channel was shoal (4½ feet) and extremely narrow across the bar.

The amount expended to and including June 30, 1886, $34,188.35, gained a channel of entrance to the river by Middle Pass of 6 feet depth, and opened the river to Liberty for vessels of 5-feet draught. The improvement is, however, only temporary. The balance of the estimate, $14,541, is required to continue work, dredging, &c., as found necessary. The work is not susceptible of permanent completion.

July 1, 1885, amount available	$506 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	194 85
July 1, 1886, amount available	311 65

Amount (estimated) required for completion of existing project	14,541 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 3.)

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*The river and harbor act of August 5, 1886, directs that the balance on hand from the money heretofore appropriated shall be expended in the completion of this channel in accordance with the plans heretofore adopted.

4. *Buffalo Bayou, Texas.*—The project of 1880 proposed the opening up of the channel between Simm's and White Oak bayous for commercial purposes. The original channel-way below Houston in 1880 was navigable for vessels drawing 6 feet of water.

The approved project carried an estimate of $385,299.75 for a channel 12 feet deep and 100 feet wide, clear of all obstructions to navigation between the points above named.

The amount expended to June 30, 1886, $99,566.25, resulted in developing an improved channel in the bayou to an extent much appreciated by the commerce thereon. The work done was that of deepening and widening the shoalest and narrowest places and clearing the stream of stumps, sunken logs, &c. One hundred thousand dollars can be profitably expended in the fiscal year ending June 30,1888, in enlarging the present channel, to the advantage of commercial interests.

July 1, 1885, amount available	$4,477 87
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,044 12
July 1, 1886, amount available	433 75
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	19,183 75
Amount (estimated) required for completion of existing project	267,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 4.)

5. *Channel over bar at mouth of Brazos River, Texas.*—The project of 1880 has for its object the maintenance of a good navigable channel across the bar; the natural channel afforded a depth of not over 8 feet, being subject to changes due to winds, tide, and stages of water in the river.

The amount expended to June 30, 1886, $139,783.47, has been applied to constructing jetties. The resulting effect of the work has been the holding of a channel across the bar sufficient in every way for the requirements of the port's navigation and commerce. The work in place is not sufficient in extent to realize permanent results so far. One hundred thousand dollars can be profitably expended in the fiscal year ending June 30, 1888, in continuing jetty construction.

July 1, 1885, amount available	$345 53
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	129 00
July 1, 1886, amount available	216 53
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	18,966 53
Amount (estimated) required for completion of existing project	364,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 5.)

6. *Pass Cavallo Inlet to Matagorda Bay, Texas.*—The project of 1879 proposes the obtaining of a channel of 12 feet depth across the bar, and the protection of the head of Matagorda Island.

The amount expended to June 30, 1886, $287,965.12, has been applied to constructing a jetty on the south side of the pass entrance, and has resulted in making a marked improvement in depth of channel across the bar, and giving the channel permanency of position in a direction more suitable for navigation.

One hundred thousand dollars can be profitably expended in the fiscal year ending June 30, 1888, in continuing jetty construction, extending and raising the south jetty in accordance with approved plan.

July 1, 1885, amount available	$22,183 05
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	20,148 17
July 1, 1886, amount available	2,034 88
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	39,534 88
Amount (estimated) required for completion of existing project	711,780 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 6.)

7. *Aransas Pass and Bay up to Rockport and Corpus Christi, Texas.*—The project of 1879 has for its object the maintenance of a 12-foot channel, at mean low water, over the bar, and the protection of the head of Mustang Island up to and beyond Turtle Cove.

The amount expended to June 30, 1886, $386,939.03 (including $9,938.93 of the fund subscribed by private parties), has been applied to protecting by groins the head of Mustang Island up to and above Turtle Cove, in conjunction with a brush and stone revetment along the channel-face of the island, and the partial construction of a jetty on the south side of the channel. The effect of this work has resulted in a permanent channel across the bar, wherein is afforded a depth of 11 feet for navigation and commerce. During 1880, in an ever-shifting channel, there was a depth available across this bar of but 5 to 5½ feet. This just prior to beginning of work here by the Government.

The officer in charge renews his recommendation for sufficient funds to continue the improvements so as to accommodate shipping up to the wharves at Rockport and Corpus Christi at an early date.

He estimates that $600,000 can be very profitably expended in the fiscal year ending June 30, 1888, in constructing jetty at the pass and improving interior channels.

July 1, 1885, amount available	$6,913 11
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,913 21
July 1, 1886, amount available	2,999 90
Amount appropriated by act approved August 5, 1886	101,250 00
Amount available for fiscal year ending June 30, 1887	104,249 90
Amount (estimated) required for completion of existing project	719,472 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 7.)

8. *Harbor at Brazos Santiago, Texas.*—The project of 1881 (only partly adopted) proposed the deepening of the channel across the bar and the maintenance of a suitable harbor inside the pass.

The depth of water over the bar, maintained by natural causes alone, was 7½ feet.

The amount expended to June 30, 1886, $184,148.72, has been applied to constructing a jetty on the south side of the entrance channel, and has resulted in maintaining a better channel than that afforded by natural causes alone.

One hundred thousand dollars can be profitably expended in the fiscal year ending June 30, 1888, in constructing the works originally estimated for.

July 1, 1885, amount available	$851 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	515 00
July 1, 1886, amount available	336 28
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	37,836 28
Amount (estimated) required for completion of existing project	455,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 8.)

9. *Protection of river bank at Fort Brown, Texas.*—This work was designed to arrest the progress of encroachment which threatens not only to destroy the most valuable buildings at the post, but to break through into the lagoon, which would entirely change the channel of the river, and leave the greater portion of the post on the opposite side of the channel.

The amount expended to June 30, 1886, is $16,996.46. The results attained have not been commensurate with the expenditure, and it has been considered best not to attempt to control the Rio Grande at this point by artificial works, and that it would be more expedient to move, from time to time, such of the buildings as may be in actual danger.

No further appropriation for this work is recommended.

July 1, 1885, amount available	$1,003 54
July 1, 1886, amount available	1,003 54

(See Appendix S 9.)

IMPROVEMENT OF RED RIVER AND OF CERTAIN RIVERS IN THE STATES OF LOUISIANA, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND PRINCIPAL TRIBUTARIES.

Officer in charge, Capt. Eric Bergland, Corps of Engineers.

1. *Red River, Louisiana and Arkansas.*—The present improvement of the river was begun in 1872. At that time navigation above Shreveport, La., was almost impossible, on account of the great raft. Low-water navigation between Shreveport and Grand Ecore, La., was seriously affected by the gradual enlargement of the Tone's Bayou outlet, which depleted the main channel of the river below without giving another navigable route. The entire river from Fulton, Ark., to its mouth, was greatly obstructed by snags, logs, wrecks, leaning trees, and similar obstructions; and the navigable channel at Alexandria was insufficient for the demands of commerce.

The project has contemplated removal of the great raft, the closure of Tone's Bayou, the removal of snags and other obstructions, the opening of a channel through the falls at Alexandria, and deepening the water over shoal places.

The work from 1872 to the end of the fiscal year 1884–'85 had greatly benefited navigation and commerce. The great raft had been removed and about 150 miles of river above Shreveport opened to navigation. By means of snag-boats and shore-parties numerous obstructions were removed, the raft kept from re-forming, and the river kept open from Fulton, Ark., to its mouth, being navigable between those points almost the entire year. Several ineffectual attempts had been made to close Tone's Bayou, but nothing has been done since early in 1882, when the dam then in process of construction was destroyed. The work of excavation at the falls of Alexandria was let by contract October 14, 1882, but had progressed slowly up to this time. The work of protecting the harbor at Alexandria, by means of a wing-dam and training-wall, was well under way when stopped by high water in December, 1884.

During the fiscal year, the channel excavation through the upper falls at Alexandria was resumed by the contractor August 20, and continued until November 25, when, the cut being practically completed, the contract was closed, a total of 7,630½ cubic yards of rock having been removed by the contractor. Many boats have passed through the cut at low stages of water, since work was discontinued, without experiencing any difficulty or meeting any obstructions. The rock and debris excavated at the upper falls were deposited in the dam at the lower falls, which sufficed to close the channel along the west shore and has changed the direction of the current from the west to the east shore; resulting in an almost total cessation of erosion of the west bank and the removal of the extensive sand-bar along the east bank. The work for the protection of Alexandria Harbor was completed according to the project, as far as the funds available would permit—the training-wall being somewhat shorter than projected, because the site had scoured out to a greater depth than when the estimates were submitted. This work, in connection with the dam at the lower falls, has been of some benefit to the river bank at Alexandria; but little caving having taken place during the fiscal year, which little was due to a stratum of quicksand causing a sloughing of the bank when the water falls. No work has been done for the general improvement of the river, as the balance available was not sufficient.

The amount expended to June 30, 1886, is $725,049.10.

The amount estimated for can be profitably expended in continuing the removal of obstructions by snag-boats and shore-parties, completing the improvement at the falls at Alexandria, and extending the work for the protection of the harbor at Alexandria.

It is of great importance that the survey of Red River, from Fulton, Ark., to the mouth, be made, the estimate cost of which is $45,000. This survey, which was included in the examinations and surveys provided for in river and harbor act of August 2, 1882, but not undertaken for want of funds, would be of the utmost importance in determining future methods of improving the river.

No estimate for the permanent improvement of the river can be presented, as new obstructions are continually added by caving banks, &c., and each flood brings down large quantities of drift from the upper river, the removal of which requires that the work be carried on from year to year in order to keep the river open to navigation.

July 1, 1885, amount available	$12,972 33
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,021 43
July 1, 1886, amount available	1,950 90
Amount appropriated by act approved August 5, 1886	75,000 00
Amount available for fiscal year ending June 30, 1887	76,950 90

Amount that can be profitably expended in fiscal year ending June 30, 1888	$100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 1.)

2. *Survey of Bayou Pierre, Louisiana.*—This was directed by river and harbor act of July 5, 1884, the object being to ascertain the advisability and cost of opening a navigable channel from Red River through Tone's Bayou and Bayou Pierre, to the point where the waters of the latter again join Red River.

The survey was begun in October, 1884, but owing to several unforeseen circumstances, which combined to make the cost exceed the original estimates, the amount appropriated was not sufficient for its completion. It is about two-thirds completed, and the remaining field work can probably be accomplished in about six weeks. No estimate of the cost of opening the Bayou Pierre route to navigation can be submitted until the completion of this survey.

It is of great importance that the survey be completed as contemplated, in order that the question of advisability and cost of opening this route to navigation may be definitely settled. The cost of completing the survey is estimated at $5,000.

July 1, 1885, amount available	$663 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	525 80
July 1, 1886, amount available	138 05

NOTE.—The river and harbor act of August 5, 1886, appropriates for the completion of this survey.

(See Appendix T 2.)

3. *Cypress Bayou, Texas and Louisiana.*—This improvement included the whole navigable channel from Shreveport, La., to Jefferson, Tex., *via* Sodo and Fairy lakes and Cypress Bayou.

The first project consisted in cutting and dredging a good high-water channel from Jefferson, Tex., to Red River, and was completed in 1880.

The second project contemplated constructing a dam across the lake at Albany Point, and making a cut through to Red River, at an estimated cost of $372,580, recommending that the funds be made available in one appropriation to successfully execute the work. No funds have been appropriated for this project.

The river and harbor act of July 5, 1884, directed a resurvey, to ascertain if the improvement could not be made upon some other plan than the above. With the small balance available only an examination could be made, and the report thereon recommended that the improvement be confined to strengthening and marking the present channel, cutting stumps therefrom, and reopening the cuts by dredging, which it is believed will secure safe navigation to Jefferson during seven or eight months of the year. The cost of this improvement is estimated at $18,000.

In order to complete the work according to the above project it is important that the whole amount be made available in one appropriation.

The amount expended to June 30, 1886, is $94,000.

July 1, 1885, amount available	$31 15
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	31 15
Amount appropriated by act approved August 5, 1886	18,000 00

(See Appendix T 3.)

4. *Cane River, Louisiana.*—The only appropriation for this work was made by river and harbor act of July 5, 1884 ($2,500). The amount expended to June 30, 1886, was $2,425.31, and has resulted in freeing the channel of obstructions to a great extent, increased the depth of water during the navigable season, and enabled steamboats to make quicker trips. No work was done during the year.

This stream being an arm or high-water channel of Red River, extending from a point 2 miles below Grand Ecore, where it leaves the main stream, to Colfax, La., where it re-enters, it is recommended that appropriations for future improvement be included in those for Red River, in which case necessary work can be done when and where the interests of navigation may require it.

July 1, 1885, amount available	$149 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	75 00
July 1, 1886, amount available	74 69

(See Appendix T 4.)

5. *Loggy Bayou, Lake Bistenau, and the Dorcheat, Louisiana.*—The only appropriation for this improvement ($5,000) was made by river and harbor act approved July 5, 1884. The amount expended to June 30, 1886, was $4,908.21, which was applied to the removal of snags, logs, stumps, leaning trees, and brush obstructing navigation; and signboards, indicating the cleared channel were set up in Lake Bistenau. This work gave increased facilities for navigation, and the navigable depth in many places was increased fully 3 feet. No work was done during the year.

The commerce of these streams has been greatly diminished by railroad connection with the principal shipping point, and it is doubtful whether the great expenditure necessary to lengthen the navigable season would be justified, hence no appropriation is asked for the next fiscal year.

July 1, 1885, amount available	$431 79
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	340 00
July 1, 1886, amount available	91 79

(See Appendix T 5.)

6. *Ouachita and Black rivers, Arkansas and Louisiana.*—The improvement of Ouachita River was begun in 1871. Black River, being the connecting link between Ouachita and Red rivers, was added under the same head of appropriation by the river and harbor act of 1884. The original project contemplated the construction of a series of locks in the Ouachita River for slackwater navigation, but, on account of the great cost and doubtful utility of the work, was abandoned in 1874, and the present project adopted. This contemplates the removal of wrecks, logs, snags, leaning trees, &c., obstructing navigation, and the improvement of shoal places between Camden, Ark., and the mouth of Black River.

The amount expended under present project to June 30, 1886, including cost of iron-hull snag-boat and outfit, was $176,320.07, which has greatly benefited navigation by the removal of obstructions, and an increased depth of from 12 inches to over 3 feet has been gained at some of the shoal places. Previous to improvement boats plied between New Orleans and Camden about half the year. These boats now run to

Camden from seven to eight months in the year, and the smaller ones ascend the river as high as Monroe, La., during the entire year.

No work was done during the fiscal year ending June 30, 1886.

The amount asked for the fiscal year ending June 30, 1888, can be profitably expended in continuing the removal of obstructions from the channel and banks of the streams, and building and repairing wing-dams where necessary.

No estimate for permanent improvement can be submitted, as the obstructions are continually forming and require removal from time to time.

July 1, 1885, amount available	$1,190 81
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,098 75
July 1, 1886, amount available	92 06
Amount appropriated by act approved August 5, 1886	17,500 00
Amount available for fiscal year ending June 30, 1887	17,592 06
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	20,000 00

(See Appendix T 6.)

7. *Bayou Bartholomew, Louisiana and Arkansas.*—This stream is navigable only during high stages of water in Ouachita River, of which it is a tributary. The improvement was begun in 1881, the project contemplating the removal of wrecks, snags, overhanging timber, &c., obstructing navigation between Baxter, Ark., and the mouth, a distance estimated at 213 miles, at a cost of $26,862.

The amount expended to June 30, 1886, was $17,978.82, and has greatly benefited navigation and lessened the dangers thereof, enabling boats to run regularly to Baxter during high water. No work was done during the year.

The appropriation asked for the fiscal year ending June 30, 1888, can be profitably expended in continuing the removal of obstructions from the channel and banks as heretofore.

No permanent improvement can be effected, as new obstructions are continually forming, which require removal from time to time in the interests of safe navigation.

July 1, 1885, amount available	$248 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	227 50
July 1, 1886, amount available	21 18
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,021 18
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	5,000 00

(See Appendix T 7.)

8. *Bayou Bœuf, Louisiana.*—This bayou is navigable only during high water. The project for its improvement was adopted in 1880, and contemplated the removal of snags, logs, leaning timber, &c., obstructing navigation between Wallace's Landing, La., and its mouth, a distance of 280 miles, at an estimated cost of $20,000. An examination of three outlets of this bayou, near Point Jefferson, La., was made in 1884, and their closure recommended at an additional cost of $8,500.

The amount expended to June 30, 1886, was $14,995.68, which has given increased facilities to navigation by the removal of obstructions, and enabled boats to run during high water to Point Jefferson, 19 miles below Wallace's Landing. No work was done during the year.

The amount asked for the fiscal year ending June 30, 1888, can be profitably expended in continuing the removal of obstructions to high-water navigation ($5,000), and in closing the outlets near Point Jefferson ($8,500).

No permanent improvement can be secured, as new obstructions are added from time to time, which will require removal in the interests of safe navigation.

July 1, 1885, amount available	$124 32
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	120 00
July 1, 1886, amount available	4 32
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,004 32
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	8,500 00

(See Appendix T 8.)

9. *Tensas River and Bayou Macon, Louisiana.*—The project for the improvement of Tensas River was adopted in 1881, and contemplated the removal of snags, logs, leaning timber, &c., obstructing navigation, from Dallas, La., to its mouth, about 180 miles, at an estimated cost of $23,000. Bayou Macon, a tributary of the Tensas, was added under the same head of appropriation by the river and harbor act of 1884, and the project contemplates the removal of obstructions, of the same class as in the Tensas, at an estimated cost of $17,000. No work has been done in the latter stream, as the amount appropriated was insufficient for the improvement of both.

The amount expended to June 30, 1886, was $7,000, which was applied to the improvement of Tensas River, and has benefited navigation by the removal of obstructions as far as practicable with that amount. No work was done during the year.

With the appropriation asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks as heretofore.

If the entire amount estimated for be granted, work can be prosecuted in both streams.

The work is not permanent, as new obstructions are added from time to time, which will require removal in the interests of safe navigation.

July 1, 1885, amount available	$15 34
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	15 34
Amount appropriated by act approved August 5, 1886	4,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	10,000 00

(See Appendix T 9.)

10. *Bayou D'Arbonne, Louisiana.*—Like the other tributaries of Ouachita River, this bayou is only navigable during high stages of water in the main stream. The project for its improvement was adopted in 1884, and contemplates the removal of snags, logs, wrecks, leaning trees,

&c., obstructing navigation from Stein's Bluff to its mouth, 42½ miles at an estimated cost of $15,000.

The amount expended to June 30, 1886, was $4,974.07, which has resulted in the removal of obstructions from about one-half of that part of the stream in which improvement is contemplated by the present project, and consequently has improved high-water navigation and lessened the danger thereof. No work was done during the year.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions to high-water navigation according to the project.

The work is not permanent, as new obstructions are added from time to time, which will require removal in the interests of safe navigation.

July 1, 1885, amount available	$130 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	104 66
July 1, 1886, amount available	25 93
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,025 93
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 10.)

11. *Yazoo River, Mississippi.*—Work in this river was begun in 1873 by removing the wrecks of eleven steamboats sunk during the late war. The project for its improvement contemplates the removal of wrecks, logs, snags, overhanging trees, &c., which obstruct the channel throughout the entire length of the stream. No permanent improvement can be effected, as each flood brings new obstructions into the river, and others are continually added by caving banks, &c. These require removal from time to time to render navigation safe.

The amount expended to June 30, 1886, was $142,998.53, and has resulted in a marked benefit to commerce and improvement of the navigable channel. The large number of wrecks and natural obstructions which had limited the navigation of the stream had been removed to such an extent that the river was navigable from its head to its mouth during the entire year, and steamboats made regular trips without much difficulty.

No work was done during the year.

The amount asked for the fiscal year ending June 30, 1888, can be profitably expended in continuing the removal of obstructions from the channel and banks of the river by means of the snag-boat and shore parties.

July 1, 1885, amount available	$1,246 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,245 00
July 1, 1886, amount available	1 47
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,001 47
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 11.)

12. *Big Sunflower River, Mississippi.*—The project for improving this stream was adopted in 1879, and contemplated building wing-dams to scour a channel of from 3 feet to 40 inches over the bars, and the removal of snags, sunken logs, and leaning timber obstructing navigation, at an estimated cost of $66,000.

The amount expended to June 30, 1886, was $42,000, and has resulted in a marked benefit to commerce and navigation by the removal of obstructions and the increased depth of water of from 18 inches to 3½ feet gained over the bars where dams have been built.

Steamboatmen state that in 1879 it took from ten to fifteen days to make a trip, which now can be accomplished without difficulty in six days at the lowest stages of water.

No work was done during the year.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks, and the construction and repair of wing-dams where necessary.

July 1, 1885, amount available	$45 38
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	45 38
Amount appropriated by act approved August 5, 1886	5,000 00
Amount (estimated) required for completion of existing project	19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 12.)

13. *Tchula Lake, Mississippi.*—The project for this improvement was adopted in 1881, and contemplated the removal of snags, logs, overhanging trees, &c., obstructing navigation, to enable light-draught steamboats to enter the lake earlier in the season. The estimated cost of this improvement was $10,000.

The amount expended to June 30, 1886, was $6,846.76, which has resulted in improving the channel and lengthening the navigable season. Much work, however, remains to be done, and new obstructions are continually forming which require removal from time to time. Consequently the improvement cannot be permanent.

No work was done during the fiscal year.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks as heretofore. As this stream is really the easterly branch of Yazoo River, extending from the head to foot of Honey Island, about 67 miles in length, it is recommended that future appropriations for its improvement be included in the general appropriation for Yazoo River.

July 1, 1885, amount available	$425 84
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	272 60
July 1, 1886, amount available	153 24
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,153 24
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 13.)

14. *Tallahatchee River, Mississippi.*—This improvement was begun in 1879. The project contemplated the removal of snags, sunken logs,

and overhanging timber obstructing low-water navigation below the mouth of Coldwater River, a distance of 165 miles, and also removal of the wreck of the steamer Star of the West, lying in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000. The river and harbor acts of 1880, 1881, and 1882, however, required the expenditure of funds above mouth of Coldwater to Batesville, Miss., and $10,000 has been expended in removing obstructions from that part of the stream.

The amount expended to June 30, 1886, was $24,000 (of which amount $14,000 had been expended in the lower river), and has resulted in the removal of a large number of obstructions, greatly increasing the capacity of the river for navigation. Previous to improvement the river from the mouth of the Coldwater to the Yazoo was navigable about six months of the year. Boats from Yazoo now run to Sharkey's Landing, 100 miles above the mouth, the entire year, but seldom go above that point at any stage of water, as the amount of commerce higher up the river is not sufficient to justify the expense of a longer trip.

No work was done during the year.

If the entire amount asked for is appropriated for the fiscal year ending June 30, 1888, the work can be carried on in both sections of the river. Should a smaller amount be appropriated, the interests of navigation would be best promoted by continuing the removal of obstructions from the lower river according to the project.

New obstructions, caused by sliding and caving banks, are continually forming, and no permanent improvement can be effected on this account.

Amount appropriated by act approved August 5, 1886	$3,500 00

Amount (estimated) required for completion of existing project	22,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 14.)

15. *Yallabusha River, Mississippi.*—This improvement was begun in 1881. The project contemplated the removal of snags, sunken logs, leaning timber, &c., obstructing navigation from Grenada, Miss., to its mouth, a distance of about 63 miles. New obstructions, caused by caving banks, &c., are continually forming, and require removal from time to time in the interests of safe navigation. Consequently no estimate for permanent improvement can be submitted.

The amount expended to June 30, 1886, was $9,000; the removal of obstructions has resulted in a greatly improved channel, and the river is now navigable from five to six months of the year, or during high and medium stages of water.

No work was done during the year.

The amount asked for the fiscal year ending June 30, 1888, can be profitably expended in removing obstructions from the channel and banks, as heretofore, for the purpose of extending the period of navigation.

Amount appropriated by act approved August 5, 1886	$2,000 00

Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 15.)

16. *Steele's Bayou, Mississippi.*—The only appropriation for this improvement was made by river and harbor act of 1884. The project con-

templates the removal of snags, logs, stumps, overhanging trees, &c., obstructing high-water navigation.

The amount expended to June 30, 1886, was $2,494.74, and the obstructions removed have benefited high-water navigation to a great extent, and lessened the danger thereof. However, much remains to be done before navigation at medium stages can become practicable and profitable. No work was done during the year.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks.

July 1, 1885, amount available	$125 26
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	120 00
July 1, 1886, amount available	5 26
Amount appropriated by act approved August 5, 1886	2,500 00
Amount available for fiscal year ending June 30, 1887	2,505 26
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	5,000 00

(See Appendix T 16.)

17. *Big Black River, Mississippi.*—The only appropriation for improving this stream was made by river and harbor act of 1884. The project contemplates removal of snags, logs, wrecks, and overhanging trees obstructing navigation between the mouth and Cox's Ferry, 130 miles above, at an estimated cost of $32,000. This improvement would not be permanent, as new obstructions are added from time to time.

The amount expended to June 30, 1886, was $4,741.62, resulting in the removal of the principal obstructions from the channel and banks for a distance of 75¼ miles up stream from the mouth.

No work was done during the year.

Two railroad and two highway bridges form obstructions to free and safe navigation at all stages of water. Until these are remedied it is recommended that no additional appropriations be made.

July 1, 1885, amount available	$879 73
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	621 35
July 1, 1886, amount available	258 38
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,258 38
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	22,250 00

(See Appendix T 17.)

18. *Big Hatchee River, Tennessee.*—This improvement was begun in 1880. The project contemplated removal of logs, snags, leaning timber, &c., obstructing navigation, from Bolivar, Tenn., to the mouth of the river, about 240 miles, to render that portion of the stream navigable for light-draught boats throughout the year. The estimated cost of such improvement was $30,000. The improvement will not be permanent, as new obstructions form from time to time.

The amount expended to June 30, 1886, was $18,766.56, and has resulted in the removal of a large number of obstructions, and benefited commerce by allowing shipment of products by river where previously railroads had a monopoly of the carrying trade. Navigation was almost impossible before this work was commenced. No work was done during the year.

The amount asked for the fiscal year ending June 30, 1888, can be profitably expended in continuing the removal of channel and bank obstructions, as heretofore.

July 1, 1885, amount available	$788 99
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	555 55
July 1, 1886, amount available	233 44
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,233 44
Amount (estimated) required for completion of existing project	8,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867	

(See Appendix T 18.)

19. *South Forked Deer River, Tennessee.*—This improvement was begun in 1883. The project contemplated removal of snags, logs, leaning timber, and similar obstructions to navigation, from the mouth of the stream to Sharon, about 114 miles above, at an estimated cost of $19,250. Operations have, however, been extended to Jackson, the head of navigation, 81 miles above Sharon. The work will not be permanent, as some obstructions are added from time to time.

The amount expended to June 30, 1886, was $5,000, which resulted in the removal of a large number of obstructions, principally overhanging timber, and greatly increased facilities for navigation. No work was done during the year.

Two railway and five highway bridges, all without draws, a log-boom, and a brush-dam form serious obstructions to the navigation of this stream. While these remain the whole river cannot be made navigable for steamboats, but that portion below the lower obstruction, about 100 miles above the mouth, and the reach from Bell's Depot to Jackson, about 60 miles, can be improved in the interests of steamboat navigation.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of natural obstructions from the channel and banks, below and above the artificial obstructions.

Amount appropriated by act approved August 5, 1886	$5,000 00
Amount (estimated) required for completion of existing project	14,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 19.)

20. *Water-gauges on the Mississippi River and its principal tributaries.*—Observations were continued at all the guages, and repairs made as far as practicable with the funds available.

By joint resolution of Congress approved February 21, 1871, the sum of $5,000 was to be appropriated annually for these gauges. As no appropriation was made for the past fiscal year, and the funds available were insufficient to maintain all the gauges, the Mississippi River Commission has paid the observers and made the necessary repairs at the gauge-stations on the Mississippi River to prevent the suspension of those important observations.

July 1, 1885, amount available	$2,117 53
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,866 39
July 1, 1886, amount available	251 14

Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 20.)

IMPROVEMENT OF ARKANSAS RIVER; OF RIVERS IN THE STATE OF ARKANSAS, AND OF BLACK RIVER IN ARKANSAS AND MISSOURI.

Officer in charge, Capt. H. S. Taber, Corps of Engineers.

1. *Removing obstructions in Arkansas River, Arkansas.*—Prior to the first improvements in 1833, shifting sand bars, numerous drift-piles, and dangerous snags constituted the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper. Except for a few special reaches, like the Fort Smith and Pine Bluff, the general plan of improvement has consisted in snagging operations, including the cutting of overhanging trees, in building wing-dams to improve the shoals, and in surveys looking to plans for its permanent improvement. The appropriations to June 30, 1886, amount to $420,376.87. Of this there had been expended to June 30, 1885, $340,214.35, resulting in great relief to navigation. During the fiscal year ending June 30, 1886, $6,321.11 were expended in the running expenses of two snag-boats, and in the care of the same. Much of the excellent service rendered by these boats in the fiscal year ending June 30, 1885, has been practically lost by there being no appropriation for the year ending June 30, 1886. Only about 30 days' work with one boat was done in the entire year, for lack of funds, and on account of the rotten condition of the hull of the light draught boat. This work being done at extreme low water gave great relief to navigation, though entirely inadequate to meet the wants of commerce.

July 1, 1885, amount available		$7,631 21
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885		6,321 11
July 1, 1886, outstanding liabilities	$297 00	
July 1, 1886, amount available		1,310 10
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		20,060 10

Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 1.)

2. *Arkansas River at Pine Bluff, Arkansas.*—The reach of river which lies in the vicinity of Pine Bluff, Ark., was in a very bad condition prior to any attempts at improvement. At one point a cut-off was threatened which would change the slope of the river from three-fourths of a foot per mile to 4 feet per mile. At another point a bad bar interfered with navigation at low water, and in the sharp bend in front of

the town of Pine Bluff the river was eroding the banks with a rapidity that threatened the town.

The original project proposed: 1. To protect the river bank in front of the town from further erosion; 2. To rectify the course of the river in the bend above town, in order to remove a bar now existing there, and also, by diminishing the curvature of the bend, to lessen the tendency to excessive scour in front of Pine Bluff; and 3. To prevent the formation of a cut-off then threatened across the peninsula opposite Pine Bluff. The whole improvement to extend over 13 miles of river.

Up to June 30, 1884, $67,287.14 had been expended with the above objects in view; 3,900 feet of the town front, beginning at Brump's Bayou, was revetted during 1881; 3,700 feet of Yell's Bend was revetted the same year to prevent the cut-off, and a wire-curtain dike 1,110 feet long was put in to affect the bar. In 1882, 3,000 feet more of Yell's Bend was revetted, and in 1883 the old works were repaired; 3,000 feet of bank in Yell's Bend was regraded, and 1,000 feet of high-water protection put in place. During the fiscal year ending June 30, 1884, little was done except to care for plant. July 1, 1884, there remained of all this work only the wire-curtain dike. This result was predicted by the various engineers in charge, inasmuch as the works had to be left in an unfinished state, owing to failure of funds. The works in Yell's Bend had existed, however, long enough to delay the advance of the river until changes above rendered the danger less imminent. The wire-curtain dike did good service, and the bar was much improved. The town, however, was left at the mercy of the river. During the high water of the spring of 1884, the front was eroded in places 120 feet and upward, and it was apparent that if something could not be done the entire business portion of the town would have to move back or be swept away.

By act of July 5, 1884, $55,500 was appropriated for this work, and of this $48,813.98 had been expended up to July 1, 1885, in such a manner as to protect the entire front, except the last two blocks.

These results were secured by plans differing radically from the original project. A dike was erected on a bar which was forming downstream. This dike was well provided with foot-mats and so deflected the river that it eroded over 275 feet of the opposite bank, and cut out a deep channel. A second dike was thrown in nearer the town, and this checking the velocity, caused the river to lose its load, which being dropped upon the layer of quicksand, kept it from being eroded, and hence no caving occurred. Dikes were made very strong and built for the peculiar action of alluvial streams. By using boxes filled with sand instead of stone the dike was built at a reduced cost of $49,000, and the balance remaining was held for contingencies.

During the fiscal year ending June 30, 1886, two additional hurdle-dikes were built to increase the deposit along the town front. Both old and new works are in excellent condition and have produced greater results than was expected. It appears now that nothing except care in watching and checking any slight change in the river's regimen is required to give security to the town.

The engineer should have annually $8,000 as a contingent for this entire reach until the permanent improvement of the river above has been made. Two or three blocks at the lower end of the town are as yet unprotected. This will be attended to with the amount appropriated by act approved August 5, 1886.

July 1, 1885, amount available		$7,073 13
Received by sale of fuel to officer		12 00
		7,085 13
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885		4,619 80
July 1, 1886, outstanding liabilities	$465 00	
July 1, 1886, amount available		2,465 33
Amount appropriated by act approved August 5, 1886		8,000 00
Amount available for fiscal year ending June 30, 1887		10,465 33
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		8,000 00

(See Appendix U 2.)

3. *Black River, Arkansas and Missouri.*—Before any improvements were made upon this river its channel was choked with logs and snags and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draught boats. Its banks caved but little, and, except at the shoals, it was characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm. The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing-dams. A few sloughs were to be closed up so as to confine the water to the main channel.

Up to June 30, 1885, $49,610.80 had been expended for these purposes. This expenditure gave great relief to navigation at certain places, but has proven inadequate to thoroughly open up the river. There is a constantly increasing demand for navigation facilities.

During the year ending June 30, 1886, nothing could be done but care for the plant, the small balance on hand being inadequate even for this. During the year $1,121.32 was expended for this purpose.

An annual appropriation of from $8,000 to $10,000 will be required to keep this river available for navigation.

July 1, 1885, amount available		$1,624 10
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885		$1,121 32
July 1, 1886, outstanding liabilities	$145 00	
July 1, 1886, amount available		502 78
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,502 78
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		10,000 00

(See Appendix U 3.)

4. *White River, Arkansas.*—Prior to improvement this river was much choked with drift-piles, logs, and snags in its lower portion, and from Batesville up, gravel bars, rocky shoals, channel bowlders, and overhanging trees impeded navigation. The original adopted project consisted in snagging operations and blasting of ledges and bowlders and dam building to remove gravel bars or to close chutes, from time to time as appropriation warranted and commerce required.

The first separate appropriation for this stream was made by act approved July 5, 1884. At the time it was passed the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water, from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsythe, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others less dangerous prevented any navigation at ordinary stages of water. The present project provides that the appropriation of July 5, 1884, be applied to removing snags and bowlders and other obstructions to navigation, building wing-dams to improve shoals, repairs and care of plant, and survey of the river, as provided for in the act, with a view to its improvement from Forsythe, Mo., as far down as funds will admit. The survey was begun early in May, 1885, and was in progress at close of last fiscal year. Except when the interests of navigation required immediate improvements, it was deemed best to do as little work as possible until the survey gave a better idea of where appropriations could be applied to best advantage. The field work of the survey was completed in 1885. It was pushed to Newport before funds were exhausted, 248 miles of river survey having been made at a cost of $11,340 in round numbers, or about $45 per mile. Estimate placed it at $80. Nearly double the distance was covered that the appropriation contemplated.

During the fiscal year ending June 30, 1886, $18,670.79 was expended, completing the survey as above and in removing obstructions at extreme low water (the survey having shown just where work was most needed) as high as Calico Rock, with some work on Buffalo Shoals in connection with another appropriation, the balance to be used in carrying the works from Calico Rock to Buffalo Shoals. This will give temporary relief until money is available for the permanent improvement.

There will be needed annually $10,000 to maintain this improved channel until the survey is completed, for which $13,634 is required. The recommendation that it be appropriated is renewed.

July 1, 1885, amount available		$26,592 63
Received by sale of fuel to officer		15 00
		26,607 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885		18,670 79
July 1, 1886, outstanding liabilities	$276 43	
July 1, 1886, amount available		7,936 84
Amount appropriated by act approved August 5, 1886		18,000 00
Amount available for fiscal year ending June 30, 1887		25,936.84
Amount (estimated) annually required to maintain present channel		10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix U 4.)

5. ***White River above Buffalo Shoals, Arkansas.***—Before any work was done on this particular reach the channel at low water was much choked by logs. In many places large bowlders rendered navigation dangerous or impossible, and in others gravel and rock shoals existed which held the water in pools. It was a reach to which lock and dam, or movable dams, could only be applied with any permanent success for low-water navigation.

The first appropriation was $50,000 by act of June 23, 1874, and this applied not only to this reach, but all the way from Jacksonport. This was expended in removing logs and the most dangerous bowlders and improving the shoals by wing-dams, but appears to have been more largely expended below this reach.

By act of August 14, 1876, $10,000 was appropriated for Buffalo Shoals. The first separate appropriation for the river above this point was by act of June 14, 1880, $20,000. It was then estimated that the total cost of the improvement would be about $101,000, which was to be largely used in improving shoal places. The next was by act of August 2, 1882, $4,000. To July 1, 1885, $23,181.63 had been expended from direct appropriations.

This expenditure has relieved navigation very much; but was too small in amount to cover only a few miles immediately above Buffalo Shoals.

During the year ending June 30, 1886, $818.37, the entire balance, was expended at Buffalo Shoals in repairing the dams, in connection with the general appropriation for the entire river.

July 1, 1885, amount available	$818 37
Received by sale of fuel to officer	6 00
	824 37
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	824 37

(See Appendix U 5.)

6. *Saint Francis River, Arkansas.*—The first *separate* appropriation made for the entire river was made under the act approved July 5, 1884. The first appropriation of any kind was made in connection with other rivers March 2, 1833, prior to which this river was choked with drift-piles, logs, and snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation. The originally adopted project was principally for snagging operations, and attempts have been made to close up some of the many sloughs. Appropriations for this river having been united with the White River and also with the Black River, exactly how much had been expended upon the Saint Francis River to June 30, 1884, cannot well be stated.

July 1, 1885, the river was in an excellent navigable condition (at medium stages) from its mouth as high as Wittsburg, Ark. During high water boats have been as high as Lester's Landing. From Lester's Landing to Saint Francis the river was very badly choked with drift and divided into many channels, thus cutting off a rapidly developing section from all facilities of transportation.

During the fiscal year ending June 30, 1886, the new outfit built the year before, after surmounting obstacles almost defying its capacity, worked through to Saint Francis, exhausting the funds, leaving a passable channel, and at once affording great relief to navigation, though doing less than one-half the work urgently required.

The recommendation that $8,000 be appropriated annually for this river is renewed.

Attention is invited to the extensive commerce awaiting the opening of the river to navigation.

July 1, 1885, amount available	$4,537 42
Received by sale of fuel to officer	6 00
	4,543 42
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,479 05
July 1, 1886, amount available	64 37
Amount appropriated by act approved August 5, 1886	8,000 00
amount available for fiscal year ending June 30, 1887	8,064 37

Amount that can be profitably expended in fiscal year ending June 30,1888	$8,000 00
Submitted in compliance with requirements of section 2 of river and harbor act of 1866 and 1867.	

(See Appendix U 6.)

7. *Saline River, Arkansas.*—Before improvement this river was obstructed by snags, logs, drift-piles, and overhanging trees, and by shoals. The original plan for improvement contemplated the rendering of its channel navigable as high as practicable or as commerce demanded by the removal of these obstructions, and then further improvement of the shoals if the commerce warranted.

There was expended upon this river up to June 30, 1885, $20,951.70. This has given much relief to navigation, and has practically cleared the river, so far as present navigation demands.

During the fiscal year ending June 30, 1886, $404.56 has been expended in caring for the property.

Until the requirements of commerce are greater than they are now it is not recommended that any further appropriation be made. From $5,000 to $6,000 per year would keep this river in a fair navigable condition during medium stages of water for 250 miles from its mouth—that is, up to Big Island—should it be required.

July 1, 1885, amount available		$568 30
Received by sale of fuel to officer		4 50
		572 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885		404 56
July 1, 1886, outstanding liabilities	$10 00	
July 1, 1886, amount availalable		168 24

(See Appendix U 7.)

8. *L'Anguille River, Arkansas.*—This river, like all the streams in eastern and southeastern portions of Arkansas, before being improved was obstructed by logs, snags, and overhanging trees, and the shoals incident to the accumulation of snags and logs. The original plan of improvement, begun in 1879, contemplated the removal of these obstacles, and up to June 30, 1885, $13,850.53 had been expended in such a manner as to remove all obstructions to navigation at medium stages of water, leaving a balance of $3,149.47.

No plant in this district was adapted to the balance of the work required except the new hand snag-boat A. B. Johnson, built in 1885 for the Saint Francis River work. It was deemed advisable to attempt no work on this river until this boat was available. During the year ending June 30, 1886, this boat became available from the exhaustion of her own appropriations, and a beginning was made upon the final work of improvement, $2,407.80 being expended. Continued high water prevented the prosecution of the work to completion during that year. A suitable stage of water is expected early in the present fiscal year, when it is believed such thorough work may be done with the balance remaining that no further appropriation will be needed in many years.

July 1, 1885, amount available		$3,149 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885		2,407 80
July 1, 1886, outstanding liabilities	$56 15	
July 1, 1886, amount available		741 67

(See Appendix U 8.)

9. ***Survey of Arkansas River, Arkansas, from Little Rock to its mouth.***—The original plan for this survey contemplated covering the river with a series of triangles, determining the shore-line, both at high and low water, the position of the bars and islands, the general topography of the valley to the bluffs, when these are not too far from the river, the depth of the water, the gauging of the river at various points and principal tributaries, the nature of the soil and character of the river-bed, cross-sections to be made at frequent intervals, the slope to be accurately determined, and all other attainable data to be collected that will bear upon the problem of the permanent improvement of the navigation of the river.

There had been expended upon this project to June 30, 1885, $17,361.79, which had completed the field work practically and placed the maps in an advanced stage of completion.

During the fiscal year ending June 30, 1886, $1,627.01 has been expended in completing the maps.

July 1, 1885, amount available	$1,930 71
Received by sale of fuel to officer	4 50
	1,935 21
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,627 01
July 1, 1886, amount available	308 20

(See Appendix U 9.)

10. ***Continuation of survey of Arkansas River from Wichita, Kansas, to Fort Gibson, Indian Territory*** (provided for in the river and harbor act of August 2, 1882).—There was expended to June 30, 1885, upon this, $9,120.87, which completed the field-work in an indifferent way, and plotted the notes after a very rough fashion.

During the fiscal year ending June 30, 1886, the balance of the allotment, $179.13, was expended in putting the maps in a little better shape, and in prepairing a rough tracing to forward with the plans and estimates for this reach of river. This still leaves the maps in a very unsatisfactory condition.

A report was prepared and submitted January 23, 1886, which was printed as House Ex. Doc. No. 90, Forty-ninth Congress, first session, with full plans and estimates for the improvement of the river from Arkansas City, Kans., to Fort Gibson, Indian Territory.

July 1, 1885, amount available	179 13
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	179 13
Amount appropriated by act approved August 5, 1886	1,125 00

(See Appendix U 10.)

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND THE MISSOURI RIVERS—IMPROVEMENT OF OSAGE RIVER, MISSOURI AND KANSAS—GASCONADE RIVER, MISSOURI.

Officer in charge, Maj. A. M. Miller, Corps of Engineers.

1. ***Removing snags and wrecks from the Mississippi and Missouri rivers.—Mississippi River.***—The channel of this river was greatly obstructed by the presence of snags and other obstructions in the bed o the stream, and overhanging timber on the banks, thus materially interfering with navigation on the river. For the removal of these obstructions appropriations were made as early as 1824, and the projec

consisted in the building of boats suitable for pulling the snags, &c., and these boats were almost continually employed during favorable boating stages in pulling the snags, &c., and cutting the leaning timber.

The total amount expended for this purpose cannot be definitely given, as previous to the appropriation made by act of March 3, 1879, no stated amount was set aside for this improvement, but a general amount was appropriated to be applied to several streams, as their needs required. From the time, March 3, 1879, when the first specific amount was appropriated up to June 30, 1885, $484,495.04 was expended for this purpose. The navigation of the river has been very materially improved by this method, and the danger of accidents to boats has been lessened.

During the fiscal year ending June 30, 1886, $20,047.71 was expended on this improvement. One snag-boat was employed between the mouth of the Missouri River and Vicksburg, Miss., removing obstructions. The boat worked two months, removing 693 snags, cutting down 567 trees, and traveling a distance of 2,256 miles. In addition the boat assisted in saving the Government plant carried down the river with the ice when the gorge below Saint Louis broke and carried the fleet with it. All the worst obstructions to navigation were removed, and commerce was greatly benefited thereby.

With the appropriation asked for fiscal year ending June 30, 1888, it is proposed to continue the snagging operations and rebuild one of the wooden snag-boats for wrecking purposes. Should this be done the navigation will be greatly facilitated during the low-water season.

No definite amount can be stated as required to complete this project. During every high-water season new snags and other obstructions are brought down and lodged in the channel; the banks are also continually caving in the river, and it is necessary to cut the timber where this is threatened to prevent the trees being caved into the river and forming new obstructions. For this reason an annual appropriation is required to properly carry on this improvement.

July 1, 1885, amount available	$28,455 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	20,047 71
July 1, 1886, amount available	8,407 88
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	64,657 88
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	129,000 00

(See Appendix V 1.)

Missouri River.—The necessity for the improvement of this stream was first recognized in 1832, as its navigation was rendered difficult and dangerous by numerous snags, &c., in the channel and leaning timber on the banks of the river.

The plan adopted for its improvement was the removal of these obstructions by snag-boats, and they have been used to great advantage in securing the result aimed at.

The first appropriations were made so as to cover the needs of several streams, a sufficient amount being allotted for each river to do the work required. For this reason the total amount expended on this river for the removal of obstructions cannot be given. Since June 18, 1878, however, when the first specific appropriation was made, up to June 30, 1885, $326,651.29 was expended in that manner. The expenditure of this money resulted in greatly improved navigation during the low-water season when the snags are very dangerous obstructions.

During the fiscal year ending June 30, 1886, $70,224.82 was expended in removing obstructions and benefiting navigation and in building the hull of a new snag-boat for this river. One snag-boat was employed in removing obstructions, working eight weeks in the river. Five hundred and forty-six snags were removed, the boat having traveled 904 miles. The hull of the new snag-boat was completed and accepted, and contracts for upper works, cabin, &c., and the machinery for the new snag-boat, were entered into.

During the coming season it is proposed to outfit the new snag-boat, and, as far as the funds available will permit, continue the snagging operations.

With the appropriation asked for fiscal year ending June 30, 1888, it is proposed to complete the outfit of new boat and continue the snagging operations, and it is expected that the worst obstructions can be removed, and navigation rendered comparatively safe.

As new obstructions are continually brought down the river, work is required every year, so no amount can be given as required to complete this work. An annual appropriation, however, is very necessary.

July 1, 1885, amount available		$113,348 71
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$70,224 82	
July 1, 1886, outstanding liabilities	42,634 17	
		112,858 99
July 1, 1886, amount available		489 72
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		22,989 72
Amount that can be profitably expended in fiscal year ending June 30, 1888		44,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix V I.)

2. *Osage River, Kansas and Missouri.*—The navigation of this stream was greatly interfered with by obstructions in the channel and shoal crossings.

The original project, adopted in 1871, was to obtain a low-water navigation of 2 feet by means of dam and training-walls, but this was abandoned and no other definite project was adopted. The improvements have consisted in the removal of overhanging trees from the banks and of snags from the bed of the stream and the construction of wing-dams and training-walls.

The amount expended to June 30, 1885, was $190,000, at which time the navigation was in a fair condition, the worst obstructions having been removed.

No work having been done on this stream since June 11, 1883, new obstructions have accumulated, thus hindering navigation.

With the amount asked for fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions, and increased boating facilities are expected.

An annual appropriation is required to keep this stream in navigable condition by the removal of new obstructions that are brought down during the floods. No stated amount can be given as required to complete the improvement.

Amount appropriated by act approved August 5, 1886	$10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix V 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, thereby greatly interfering with navigation.

Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of the snags and logs and the cutting of the leaning timber.

The amount expended on this improvement to June 30, 1885, was $28,875.28, and at that time the navigation was improved so much that boats could navigate the stream with but little danger and for longer periods during the year. During the fiscal year ending June 30, 1886, $195.67 was expended in caring for plant, no field work having been done.

No work will be done during the coming season, the funds on hand not being sufficient for that purpose, unless a further appropriation is made.

With the amount asked for fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions, and it is expected that commerce will be greatly benefited thereby.

The original estimate for the improvement of this stream was $50,000, of which $30,000 has already been appropriated, leaving an estimated amount of $20,000 to complete the project. This amount will probably be exceeded, however, as new obstructions are continually brought down the river, and it will require a small amount each year to keep the channel open after the principal work has been done.

July 1, 1885, amount available	$1,124 72
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	195 67
July 1, 1886, amount available	929 05
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	8,429 05
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix V 3.)

MISSISSIPPI RIVER COMMISSION.

This Commission, organized under the provisions of the act of June 28, 1879, reports to and receives instructions from the Secretary of War, through this office.

The Secretary of War transmitted to the House of Representatives January 15, 1886, a report from the Commission, of December 8, 1885, exhibiting the financial condition of their work on December 1, 1885, and the operations prior to that date and subsequent to June 30, 1885, and also describing, from a recent inspection of the river, the condition of the work of improvement executed by the Commission. This report was printed as House Ex. Doc. No. 38, Forty-ninth Congress, first session. (See also Appendix V V.)

The estimates for the fiscal year ending June 30, 1888, submitted by the Commission, are as follows:

For improving the Mississippi River below Cairo, Ill		$5,000,000
Continuing surveys of the river between Head of the Passes and its headwaters		100,000
Salaries and traveling expenses of Mississippi River Commission, and for salaries and traveling expenses of assistant engineers under them, and for office expenses and contingencies		100,000
Improving harbors on the river below Cairo, Ill., namely:		
At Columbus, Ky	$61,750	
At Hickman, Ky	251,750	
At Memphis, Tenn	25,000	
At Greenville, Mo	148,500	
At New Orleans, La	608,600	
		1,095,600
Total		6,295,600

MISSOURI RIVER COMMISSION.

This Commission, organized under provisions of the river and harbor act of July 5, 1884, reports to and receives instructions from the Secretary of War, through this office.

The first report of the Commission was transmitted to the Senate by the Secretary of War January 7, 1885, and printed as Senate Ex. Doc. No. 24, Forty-eighth Congress, second session.

The second report of the Commission, containing in detail the project of surveys and of works of construction carried out from December 1, 1884, to October 13, 1885, was printed in the last Annual Report of this office.

The third report, describing operations under their charge from the close of the fiscal year ending June 30, 1885, to December 1, 1885, being supplemental to that above mentioned, was transmitted to the House of Representatives by the Secretary of War, January 15, 1886, and printed as House Ex. Doc. No. 41, Forty-ninth Congress, first session. (See also Appendix W W.)

The estimates submitted by the Commission for the fiscal year ending June 30, 1888, are as follows:

For improving Missouri River from mouth to Sioux City, Iowa	$1,000,000
For surveys and examinations	120,000
For office and traveling expenses and salaries of Commissioners	30,000
Total	1,150,000

IMPROVEMENT OF THE MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA.

Officer in charge, Capt. C. B. Sears, Corps of Engineers.

The supervision of the work in progress on this portion of the river having passed to the Missouri River Commission by provisions of the river and harbor act of July 5, 1884, report of operations here during the fiscal year ending June 30, 1886, is made by that Commission.

The river and harbor act of August 5, 1886, in making appropriations for continuing this improvement, returns its supervision to the Chief of Engineers, as heretofore.

Amount appropriated by act approved August 5, 1886	$60,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	135,000 00

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

Officer in charge, Capt. James B. Quinn, Corps of Engineers.

During the past season the work has progressed in accordance with present project and has consisted in the construction of brush-dams, for the closing of chutes and cut-offs in the portion of the river below Glendive. These dams aggregate a total of 1,282 linear feet and were built at an average cost of $5.79 + per linear foot, the lowest average rate as yet reached in the construction of such works on the Yellowstone River.

ESTIMATES.

For necessary plant to continue operations	$14,000
For expenses of working parties for one season's operations	25,700
For repairs to dams	5,000
For new barges and dredge-boat	30,000
Total that may be profitably expended during the next year	74,700

Exclusive of repairs to dams the cost of the improvement of the river from Glendive to the mouth will not probably exceed $106,000.

July 1, 1885, amount available		$10,112 32
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$8,402 56	
July 1, 1886, outstanding liabilities	1,016 25	
		9,418 81
July 1, 1886, amount available		693 51
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		19,443 51
Amount (estimated) required for completion of existing project		106,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		50,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix W.)

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM THE MOUTH OF THE ILLINOIS TO THE MOUTH OF THE OHIO.

Officer in charge, Maj. O. H. Ernst, Corps of Engineers.

The supervision of the work in progress on this portion of the river having passed to the Mississippi River Commission, by provisions of the river and harbor act of July 5, 1884, report of operations here during the fiscal year ending June 30, 1886, is made by that Commission.

The river and harbor act of August 5, 1886, in making appropriation for continuing this improvement, returns its supervision to the Chief of Engineers as heretofore.

Amount appropriated by act approved August 5, 1886	$375,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	600,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM DES MOINES RAPIDS TO THE MOUTH OF ILLINOIS RIVER.

Officer in charge, Capt. E. H. Ruffner, Corps of Engineers.

The supervision of the work in progress on this portion of the river having passed to the Mississippi River Commission by provisions of the river and harbor act of July 5, 1884, report of operations here durin the fiscal year ending June 30, 1886, is made by that Commission.

The river and harbor act of August 5, 1886, in making appropriatio for continuing this improvement, returns its supervision to the Chief Engineers as heretofore.

Amount appropriated by act approved August 5, 1886 .... $150,000

{ Amount that can be profitably expended in fiscal year ending June 30, 1888 264,000
{ Submitted in compliance with requirements of section 2 of river and
{ harbor acts of 1866 and 1867.

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI BETWE SAINT PAUL AND DES MOINES RAPIDS, INCLUDING IMPROVEMEN AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—OPERATION AN CARE OF THE DES MOINES CANAL.

Officer in charge, Maj. A. Mackenzie, Corps of Engineers.

1. *Upper Mississippi River; operations of snag-boats and dredge-boat &c.*—There being no funds available from this appropriation sma allotments were made from the general appropriations for improvemen of the river between Saint Paul and the mouth of the Illinois River, b means of which the snag-boat General Barnard was enabled to mak one hurried trip over the district named. Only the worst obstructio were removed. The snag-boat J. G. Parke was not in commission du ing the year. From lack of care during the past year the river is no more obstructed by snags and overhanging trees than for several year The total amount expended for snag-boat service on Upper Mississip River between Saint Paul and the mouth of the Missouri to July 1, 188 is $502,140.

The officer in charge submits an estimate of $30,000 for operating th snag-boats during fiscal year ending June 30, 1888, and recommend that the appropriation be made a permanent one, such as those mad for the Government canals, in order to do away with the trouble e perienced through the failure of river and harbor bills.

Amount appropriated by act approved August 5, 1886 .... $22,500

{ Amount that can be profitably expended in fiscal year ending June 30, 1888 30,000
{ Submitted in compliance with requirements of section 2 of river and
{ harbor acts of 1866 and 1867.

(See Appendix X 1.)

2. *Mississippi River from Saint Paul to Des Moines Rapids.*—Wi the small amount of funds available but little work could be don During the year the work of improvement was carried on in the co struction of brush, rock, and pile dams and shore protections at Sai Paul, between Saint Paul and Hastings, in vicinity of Fountain Cit and in Coon and Cassville sloughs. A small island below Alma, ve troublesome to raft navigation, was removed by dredge. Considerab dredging was done at West Saint Paul to form a basin or harbor ther and a system of buoys was maintained on Rock Island Rapids.

Though the river reached a low stage in September, 1885, the lar boats were able to reach Saint Paul throughout the season, owing improvements made in former years.

The work is no longer experimental, but certain of good results, a the Government is now well provided with equipments in the way steamboats, barges, &c., and can expend to advantage the amou

($1,500,000) recommended by the officer in charge. The total amount expended to July 1, 1886, under this title of appropriation is $1,170,915.10.

July 1, 1885, amount available		$75,992 45
Received from sale of fuel	$105 03	
Received from sale of rock	1,078 05	
		1,183 08
		77,175 53
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	68,090 63	
July 1, 1886, outstanding liabilities	215 65	
		68,306 28
July 1, 1886, amount available		8,869 25
Amount appropriated by act approved August 5, 1886		382,500 00
Amount available for fiscal year ending June 30, 1887		391,369 25
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix X 2.)

3. *Mississippi River from Des Moines Rapids to mouth of the Illinois River.*—In April, 1885, an allotment of $5,000 was assigned to Major McKenzie from this appropriation for snag-boat operations. Of the amount available July 1, 1885, a portion was expended during the year in removing snags between Keokuk and the Illinois River, and in care and repair of snag-boats General Barnard and J. G. Parke.

July 1, 1885, amount available	$4,324 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,598 54
July 1, 1886, amount available	1,725 96
Amount appropriated by act approved August 5, 1886	150,000 00
Amount available for fiscal year ending June 30, 1887	151,725 96

(See Appendix X 3.)

4. *Harbors of Refuge in Lake Pepin: Harbor at Stockholm, Wisconsin.*—The project for this work proposed the building of a breakwater to protect and facilitate the landing of steamboats and afford safety to rafts caught in the lake by storms. A crib-work pier 579 feet in length was completed during the fall of 1885. It has passed through one winter without being injured by ice, and has already proved of considerable advantage to boats and rafts. The amount expended to June 30, 1886, is $18,748.41. No further appropriation is asked for for the fiscal year ending June 30, 1888.

July 1, 1885, amount available	$20,831 30
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	14,579 71
July 1, 1886, amount available	6,251 59

(See Appendix X 4.)

5. *Harbors of refuge in Lake Pepin: Harbor at Lake City, Minnesota.*—The project for this work proposed the building of a breakwater to protect and facilitate the landing of steamboats and afford safety to rafts caught in the lake by storms. No work has as yet been done, and no money expended, but preparations are being made for constructing a pier on a plan so modified as to afford reasonably good results with the small amount of money available.

July 1, 1885, amount available	$25,000 00
July 1, 1886, amount available	25,000 00
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	35,000 00

(See Appendix X 5.)

6. *Removal of bar in Mississippi River opposite Dubuque, Iowa.*—The original project for this work embraced the removal of the bar extending along the river front so as to give 4 feet at extreme low water. The bar had been very troublesome at low water, nearly blockading the city and causing boats to make a wide detour to effect a landing.

The work heretofore accomplished has consisted in dredging away the bar along the landings and in mid-river, affording ample depth at all stages and furnishing a wide and deep entrance to the ice-harbor.

During the past year the bars opposite to and above the entrance to the ice-harbor and along the shore for about 1,000 feet above were removed by dredge to the depth of 4½ feet at low water, as also considerable deposits at the lower landings and at the foot of the mid-river bar; 37,968 cubic yards of material were disposed of by dumping on the bar below Dunlieth.

This work affords about 1,200 feet of additional landings for steamboats and rafts.

The amount expended to June 30, 1886, is $39,140.69.

No further appropriation is asked for.

July 1, 1885, amount available	$7,141 82
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	5,282 51
July 1, 1886, amount available	1,859 31

(See Appendix X 6.)

7. *Ice-harbor at Dubuque, Iowa.*—The project for this work, submitted December 31, 1880, proposed to deepen and enlarge Waple's Cut, a basin used by boats for years as a winter harbor, so as to afford 6 feet depth at extreme low water over an area of about 500,000 square feet. The original estimate was $40,000, and that amount was appropriated in two installments.

Some minor modifications in the plan have afforded an increase of dredged area to 520,000 square feet, and that portion of the work is completed. The amount now available will be sufficient to protect the first street side of the harbor whenever the city sees fit to establish the proper width and slope at that street. The amount expended to June 30, 1886, is $35,496.01.

No further appropriation is asked for.

July 1, 1885, amount available	$11,254 20
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,750 21
July 1, 1886, amount available	4,503 99

(See Appendix X 7.)

8. *Rock Island Rapids, Mississippi River.*—During the past year a system of buoys for guidance of navigators was maintained, the expense of which was borne by the general appropriation for the river from Saint Paul to Des Moines Rapids, there being no money specially appropriated for the purpose.

The officer in charge recommends an annual appropriation of $5,000 to provide for the care of the Rock Island Rapids by maintaining the system of buoys and removing sand, loose rock, bowlders, &c., from the channel, and further urges that the Rock Island Rapids be put on the same basis as the canal at the Des Moines Rapids and be provided for by a permanent annual appropriation.

The amount expended to June 30, 1886, is $1,166,608.50.

The river and harbor act of August 5, 1886, appropriates the sum of $6,000 to be applied to the removal of the rock at Duck Creek Chain.

(See Appendix X 8.)

9. *Des Moines Rapids, Mississippi River.*—This work was commenced in 1866. The adopted plan consisted in building a closed canal 8 miles long and in cutting an open channel in the rocky bottom of the river over the remaining 4 miles of the rapids. The canal was opened August, 1877, although not fully completed, and has been in operation since that time.

The work of the past year has consisted in the continuation of riprapping canal embankment, cutting of stone preparatory to raising side-walls of lower lock, building two additional cribs above the guard-lock to facilitate entrance to the canal, and repairing portions of the plant. The work remaining to be done to complete this work in accordance with the modified project is as follows:

Completing blasting and dredging in open channel, raising lock-walls of middle and lower locks 4 feet, refilling and completing paving of embankment, building two sluices for removing sediment, building an office at lower lock, and completing the lock grounds. There is also to be built, in accordance with requirements of the act of Congress of July 5, 1884, a pier connecting the outer wall of the canal with the pier of Keokuk Bridge, for which purpose $10,000 was allowed by Congress.

The amount of money allotted by Congress for pier construction is not sufficient for the purpose, and it has not been deemed prudent or in the interest of navigation to commence the work until funds are available for its completion. It is now thought that a floating boom, which can probably be built for the $10,000 available, will be preferable (considering relative cost) to the permanent pier.

There has been appropriated and allotted for this work $4,491,700, and the net cost to the United States to date has been $4,480,680.88. There is now required to complete work in accordance with modified project $101,745, making estimated total cost of work $4,582,425.88. Certain errors in previous reports of appropriations and cost are now corrected and the figures here given are absolutely correct.

The good of this work requires that the amount needed for completion be granted at as early a date as is practicable. The work has now dragged through many years and its total cost has been increased thereby. When the improvement of the Des Moines Rapids is completed the expense of operating the Des Moines Rapids Canal will be somewhat reduced.

July 1, 1885, amount available	$30,387 15
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	20,387 15
July 1, 1886, amount available	10,000 00
Amount appropriated by act approved August 5, 1886	26,250 00
Amount available for fiscal year ending June 30, 1887	36,250 00

Amount (estimated) required for completion of existing projects	$30,495 00
Amount added for completion of modified projects	45,000 00
	75,495 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	75,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix X 9.)

10. *Operating and care Des Moines Rapids Canal.*—During the past fiscal year the Des Moines Rapids Canal was open for navigation 238 days, during which time there passed through it 784 steamboats and 218 barges, carrying 22,221 passengers, 56,001 tons merchandise, 465,681 bushels grain, 22,769,823 feet of lumber, 3,195,360 feet of logs, 8,253,000 shingles, and 4,302,800 lath.

A favorable stage of water during the spring of 1886 permitted boats and rafts to pass over the rapids around the canal, and the traffic of the year was thereby reduced. Repairing canal embankments and removing deposits washed in from adjoining bluffs were, as heretofore, a continued source of trouble and will so continue until the improvement of the Des Moines Rapids according to modified project is completed. Sixty-five thousand nine hundred and seventy cubic yards of material were removed from the canal by dredges during the year.

Electric lights were put up at Guard Lock during the year, and the similar lighting of Middle Lock during coming year will complete the system. The approved project for past fiscal year authorized the expenditure of $45,500. The expenses of year, including outstanding liabilities of previous year and extensive repairs, have been $43,009.53.

There has been appropriated and allotted to date for this work $360,500, and the net expense to the United States for same time has been $360,497.41. These figures are absolutely correct, and eliminate certain errors which have found their way into previous reports.

The standing estimate for operating and care of canal, including ordinary repairs, &c., is $40,000, and when improvement of the Des Moines Rapids and Canal and the river improvement in the vicinity of Montrose are completed, expenses can be brought considerably inside of this amount, but at present the large expenses for dredging and repairs to embankment may necessitate a slight increase of expense over that originally contemplated. By the approved project for the fiscal year ending June 30, 1887, a possible expenditure of $40,000 is authorized.

Amount available on approved project for fiscal year ending June 30, 1886		$45,500 00
July 1, 1885, balance on hand	$12 12	
June 30, 1886, amount drawn from Treasury under indefinite appropriation	43,000 00	
		43,012 12
June 30, 1886, amount expended during fiscal year, including $60.82 outstanding June 30, 1885		43,009 53
June 30, 1886, balance on hand		2 59
July 1, 1886, amount available under indefinite appropriation on approved project for fiscal year ending June 30, 1887		45,000 00

(See Appendix X 10.)

11. *Dry-dock at Des Moines Rapids Canal.*—The project for this work provides for the building on the river side of Des Moines Rapids Canal, above Middle Lock, of a dry-dock 400 feet long and 100 feet wide, with gates giving an opening of 80 feet into the canal. The estimated cost is $125,000.

For work of past year there has been available but $8,555.72, and comparatively little work has been accomplished. The present condition of dock is as follows: The earthen embankment has been finished, the paving on outer slope and on a large portion of inner slope of dock embankment has been completed; the sluice-ways have been completed, excepting arched covering and coping.

The principal work remaining to complete dock is the construction of abutments, wing-walls, and gates at entrance to dock, paving prisms, completing sluice-ways, and paving of inner slope of embankment, removing portion of canal embankment, and placing pumping machinery.

There has been appropriated for this work to date $60,000, and there is required to complete this work according to approved project $65,000. The allowance of this amount in one sum and at an early date will be in the interest of economy.

July 1, 1885, amount available	$8,555 72
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,555 72
Amount appropriated by act approved August 5, 1886	48,750 00
Amount (estimated) required for completion of existing project	16,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	16,250 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix X 11.)

PRESERVATION OF THE FALLS OF SAINT ANTHONY AND IMPROVEMENT OF THE MISSISSIPPI ABOVE THE FALLS—IMPROVEMENT OF CHIPPEWA AND SAINT CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI.

Officer in charge, Maj. Charles J. Allen, Corps of Engineers.

1. *Preservation of the Falls of Saint Anthony.*—In 1868 an attempt by private parties to tunnel under the limestone ledge forming the Falls was followed by undermining and subsidence of a large portion of the ledge. This, with the rapid recession of the crest, threatened the existence of the Falls, and the aid of Congress was invoked, the plea being that destruction of the Falls would result in converting the river above them into a series of rapids to the destruction of its navigation. The first appropriation made by Congress to preserve the Falls of Saint Anthony was $50,000, by act approved July 11, 1870. This was followed by three appropriations of $50,000 each, in 1871, 1872, and 1873, the whole aggregating $200,000, which was applied in efforts to avert the threatened danger by surrounding the chasms by coffer-dams and a stone wall; also, in closing the openings or tunnels leading from the chasms with gravel, clay, &c.

The present project for the preservation of the Falls, adopted in 1874, provided for the construction of a concrete dike underneath the limestone ledge to prevent percolation through, and consequent destruction of, the soft underlying sand-rock; the construction of flooding, or rolling, dams to keep the upper surface of the ledge flooded during the winter in order to prevent injurious action upon it of frost; and a timber apron and wings to prevent recession of the crest and consequent destruction of the dike. The dike was completed in 1876 and the other works by 1878. Since 1878 work has been confined to the preservation and repair of the timber structures. No work of repairs was done during the past fiscal year for want of funds.

The concrete dike is in good condition, but the wing and apron are very much undermined by the action of ice and water, and of loose saw-logs, which find their way to the apron from the log-booms above the Falls.

The rock filling of the apron crib-work has been removed in large part by the undermining action of the water, and the deck planking is in parts torn off by running ice and logs. Should the timber apron be destroyed the ledge would recede until the concrete dike would be endangered. The dike was constructed simply to serve as a diaphragm impervious to running water, and is not calculated to withstand—unaided by the sand-rock on its down-stream side—pressure due to a great head of water.

The occupation of about two-thirds the width of the stream above the crest of the Falls by the dams and other works of the water-power companies chartered in 1857, forcing the greater part of the flood volumes of the river through a width of 450 feet, narrowing down to 360 feet, and through a fall of 45 feet to act upon the river bed at the foot of the Falls accelerated the rate of recession of the crest prior to the completion of the apron, and renders the work of protection at the present time difficult and expensive.

The officer in charge, after stating his opinion that the best plan to secure the preservation of the Falls would consist in the removal of most, if not all, the mill-dams from the bed of the stream, extending the rolling-dams from bank to bank, and largely extending the apron-work, estimates that should the Government adhere to the present project of exterior protection the cost of repairs and extensions immediately necessary would be $210,000, of which amount $150,000 could be expended in the fiscal year ending June 30, 1888, toward extending the main apron along the front of Farnham and Lovejoy's mill-pond, protecting this front so far as necessary, removal of a portion of the point of rocks from the river, near the lower end of the pond, in order to reduce the eddy, repairing the main apron and east apron, continuing the line of submerged cribs across the bed of the river at the toe of the apron, and for general repairs.

The total amount expended under the present project (including in this the appropriation of $10,000 for a log sluice by act of Congress approved March 30, 1879) to June 30, 1886, including outstanding liabilities, is $414,985.29.

July 1, 1885, amount available		$459 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$357 75	
July 1, 1886, outstanding liabilities	86 83	
		444 58
July 1, 1886, amount available		14 71
Amount (estimated) required for project		210,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Y 1.)

2. *Mississippi River above Falls of Saint Anthony, Minnesota.*—The present project, adopted in 1880, consists in improvement of the river mainly between Aitken and Grand Rapids, a distance of 165 miles, by removal of snags, bowlders, bars, and leaning trees from the channels, and construction of wing-dams where necessary to afford 3 feet depth during low-water stage. The cost is based upon the results of a survey in 1874, the estimate for improving the extent of river from Conrad's Shoals to Grand Rapids, 252 miles, including the stretch from Aitken to Grand Rapids, being placed at $54,127.50. The last appropriation

for this improvement was that of $10,000 by the river and harbor act passed August 2, 1882.

No work was done upon the channels during the past fiscal year for want of funds.

Total expended under the present project to June 30, 1886, including outstanding liabilities, $34,998.10.

Before improvement commenced in 1880, the stream between Aitken and Grand Rapids was so obstructed that at low, and even high, stages of water, navigation was difficult and at times almost impossible for steamers of lightest draught. There is now a general depth in the improved channels of 3 feet at low water, and the three completed reservoirs at the headwaters of the Mississippi River above Grand Rapids may be relied upon henceforth to provide sufficient depth for the steamers which carry passengers, supplies, and freight to the settlements and lumbermen's camps above Aitken; but there are many snags, leaning trees, bowlders, and gravel-bars yet remaining to be removed, as they contract the channels and thus interfere with the movement of steamers at any stage of water.

Prior to the adoption of the present project the sum of $45,000, appropriated by acts of Congress June 23, 1874, and August 14, 1876, had been expended between the Falls and Saint Cloud, 76 miles above the Falls, in the removal of sand, gravel, and bowlder-bars, and construction of wing-dams. But steamboat navigation having discontinued upon that stretch of river, the present project was adopted, as already stated, in 1880.

The sum of $15,000 asked for the fiscal year ending June 30, 1888, is to be expended in continuing removal of obstructions to navigation between Aitken and Grand Rapids.

July 1, 1885, amount available		$251 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$246 33	
July 1, 1886, outstanding liabilities	3 67	
		250 00
July 1, 1886, amount available		1 90
Amount (estimated) required for completion of project, viz, improvement between Grand Rapids and Conradi's Shoals		19,127 50
Amount that can be profitably expended in fiscal year ending June 30, 1888		5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Y 2.)

3. *Construction of lock and dam on Mississippi River at Meeker's Island, Minnesota.*—The project for this work is given in the report of the Chief of Engineers for the fiscal year ending June 30, 1874, and the cost estimated at $922,121.46, the object being to connect with the improvement of the Mississippi River below Saint Paul, so as to secure steamboat navigation up to the Falls of Saint Anthony.

No improvement of the river between Saint Paul and the site of the proposed lock and dam has been authorized by Congress.

The act approved July 23, 1868, made a grant of 200,000 acres of public lands to the State of Minnesota to aid in constructing a lock and dam at this point in accordance with plan and estimate previously submitted.

The act of March 3, 1873, appropriated—

> For construction of the lock and dam on the Mississippi River at Meeker's Island, Minnesota, according to the surveys and plans of the War Department, twenty-five thousand dollars: *Provided*, That all rights and claims in and to said land grant made

to the State of Minnesota for the above work by act approved July twenty-third, eighteen hundred and sixty-eight, shall be fully relinquished to the United States before any of this appropriation is expended.

None of this appropriation has been used, the required relinquishment not having been made, and the appropriation has been lying unused for thirteen years.

No appropriation is asked for the fiscal year ending June 30, 1888.

July 1, 1885, amount available, subject to conditions in act	$25,000 00
July 1, 1886, amount available, subject to conditions in act	25,000 00

Amount (estimated) required for completion of existing project	897,121 46
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 3.)

4. *Chippewa River, Wisconsin.*—This work consists in the construction of dams and jetties to confine the low-water volume to a practicable channel, and in revetment of caving bends, between Eau Claire and the mouth of the river, a distance of 57 miles. The project was adopted in 1876, and its cost, based upon the results of an examination in 1875, was placed at $75,790; revised estimates in 1883, however, brought the cost up to $132,476.35.

Work on the improvement, during the past fiscal year, was limited to some needed repairs to the west jetty at the mouth of the river, the balance of funds available from the appropriation of 1884 only sufficing for small repairs.

Expended to June 30, 1886, including outstanding liabilities, $97,380.13.

Wherever dams and jetties have been constructed the low-water channel has been benefited, a depth of 3 feet being generally maintained where, before improvement, the depth seldom exceeded 18 inches. The improvement has been principally confined to the 16½ miles of river between the mouth and Durand.

The jetties at the mouth of the river have been of great benefit to raft and steamboat navigation in securing a stable channel of sufficient depth where, before improvement commenced, there was a broad bar intersected by shallow, shifting channels passable with difficulty at times of low water by rafts and steamers.

A number of shoals between Durand and the mouth yet need improvement. Improvement of the channel at Shaw's Rapids, Eau Claire, is much needed, the flood of September, 1884, having almost obliterated the old channel at that point.

The sum of $30,000 asked for the fiscal year ending June 30, 1888, to be expended in furtherance of the plan of improvement from the mouth to Eau Claire, including Shaw's Rapids.

July 1, 1885, amount available		$1,710 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,074 76	
July 1, 1886, outstanding liabilities	16 00	
		1,090 76
July 1, 1886, amount available		619 87
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		19,369 87

Amount (estimated) required for completion of existing project	15,726 35
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,750 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 4.)

5. *Chippewa River, at Yellow Banks, Wisconsin.*—The object of this ork is to prevent erosion of the high sand-banks or bluffs on the Chip-ewa River below Eau Claire and thereby relieve the channels of this iver and of the Mississippi below the junction of the two streams from he masses of sand contributed by those banks.

The project for improvement was adopted in 1883 following an appro-riation of $30,000 for the work by act of Congress passed August 2, 882. The estimated cost of the work, based upon the results of a sur-ey reported upon January 30, 1875, was originally placed at $64,102.50. he estimate, however, as revised June 30, 1883, was increased, it hav-ng been found from experience as the work progressed that the cost er linear foot of protection was about $4, thus making the cost of pro-ecting the 24,000 linear feet of banks $96,000.

The protection work consists of revetment of piles, brush, and sand t foot of slopes.

	Linear feet.
anks protected since commencement of work	4,969
anks partially protected since commencement of work	3,145
anks upon which no work has been done	15,886

Total expended on the project to June 30, 1886, including outstanding abilities, $29,745.16.

No work of protection was done during the past fiscal year for want f funds.

The sum of $30,000 asked for the fiscal year ending June 30, 1888, to e expended in completing the work at Waubeek, Rumsey's, and Mary ean banks.

ly 1, 1885, amount available		$296 59
ly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$37 75	
ly 1, 1886, outstanding liabilities	4 00	
		41 75
ly 1, 1886, amount available		254 84
Amount (estimated) required for completion of existing project		66,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		15,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix Y 5.)

6. *Saint Croix River, below Taylor's Falls, Minnesota and Wisconsin.*—he original project, adopted in 1878, was based upon the results of a sur-ey made in 1874, when the Saint Croix was at a high stage of water d comparatively few obstructions visible. Estimated cost, $21,758. he project, which was followed until 1880, resulting in lessening the ifficulties of navigation, contemplated removal of obstructions from e channels between Taylor's Falls, Minnesota, and Prescott, Wis. xpended under this project, $18,000.

The present project, adopted in 1880 and modified as to cost in 1882, nsists in the removal of snags, bowlders, wrecks, leaning trees, and nd-bars from the channel between Taylor's Falls and Prescott, and e contraction of the low-water channel into one of nearly uniform idth, especially at the bars and crossings, by means of jetties of brush d stone and dams of same material to close island chutes and sec-dary channels. Estimated cost, $83,450.

During the fiscal year the training-wall across the bar at Hudson was tended 165 feet, and 758 feet of the wall were protected against scour ith brush, stone, and gravel, and 3,000 cubic yards of material were removed from the improved channel at Catfish Bar. These bars are below Stillwater.

The work, since the adoption of the present project, has resulted in a least depth of 3 feet on the improved bars above Stillwater, and 5 feet on the bars below that place. It may be said of the work done that at many places navigation has been made permanent where formerly it was uncertain, and that in other places it has been made practicable. where before improvement commenced it was impossible. Expended under the present project to June 30, 1886, including outstanding liabilities, $56,588.42.

Some bars above Stillwater yet require improvement. Below Stillwater the wall at Hudson Bar should be extended, and the lower part of the improved channel dredged; and a brush dam should be built out from the right bank at Catfish Bar, to maintain the improved channel at that point. These channels are depended upon for the heavy steamboat and lumber-rafting business of Stillwater.

The sum asked for the fiscal year ending June 30, 1888, to be expended in furtherance of the existing project, and principally at Hudson and Catfish bars, and in repairs to and extension of the revetment at Kelly's Island, where a diversion of the channel has been threatened for several years past.

July 1, 1885, amount available		$2,882 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,450 28	
July 1, 1886, outstanding liabilities	20 82	
		2,471 10
July 1, 1886, amount available		411 58
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,911 58
Amount (estimated) required for completion of existing project		19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		19,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix Y 6.)

7. *Minnesota River, Minnesota.*—For want of funds no work for improvement was done during the past fiscal year. The last appropriation for this stream was $10,000, made by the river and harbor act of Congress approved June 18, 1878.

The original plan for the improvement of the Minnesota River was based upon the results of an examination made in 1866. Two plans were considered. viz, one to provide for 4 feet of water from the mouth to the Yellow Medicine River by means of locks and dams, at cost of $775,500; the other to secure 2 to 3 feet of water throughout the same distance by removal of snags and bowlders in addition to the construction of a lock and dam at Little Falls and the operation of a scraper and dredge-boat, at a cost of $117,000. Following this report and also a report made in accordance with requirement of section 2, of act approved June 10, 1872, Congress appropriated in all $77,500, which was applied to removal of snags, bowlders, and overhanging trees between Minnesota Falls and Mankato.

By act of Congress approved June 23, 1874, an appropriation of $10,000 was made "for the survey or improvement of the Minnesota River." This sum was applied to a survey from the mouth of the river to South Bend, 116.4 miles, to determine the practicability of improvement by means of canals, locks, and dams. The survey proved the possibility of lock and dam navigation for the distance passed over, the estimated cost being—

For five locks and dams	$699,283 53
And for removal of snags, &c	34,585 10
Total	733,868 63

Following the report of this survey, upon which is based the present plan of improvement, so far as removal of obstructions is concerned, Congress appropriated $30,000 for the stream by acts of 1875, 1876, and 1878, which sum was applied to clearing the river of obstructions below South Bend.

The result of the work was to clear of obstructions long stretches of the river. Little or no use, however, was made of the improved channels, there being no steamboat navigation of importance on the river.

No appropriation is asked for the year ending June 30, 1888.

There has been expended upon the present project of improvement to June 30, 1886, including outstanding liabilities, $29,967.

July 1, 1885, amount available	$42 00
July 1, 1886, outstanding liabilities	9 00
July 1, 1886, amount available	33 00

(See Appendix Y 7.)

8. *Red River of the North, Minnesota and Dakota.*—The present, which is also the original, project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877 and amended as to cost in 1883, consists in removal of snags, leaning trees, and bowlders, and in dredging channels through the bars. Estimated cost, $179,310.18. During the past fiscal year dredging was continued to a point 47 miles by river below Grand Forks, 3,950 linear feet of channels having been excavated through the bars, the work covering 15 miles in extent of river.

The first work of improvement was done in 1877. The total of work to date may be briefly summarized as follows:

Number of miles over which work has been done, including dredging, removal of snags, bowlders, &c	275
Number of miles passed over by dredges	127
Number of channels cut by dredges	101
Number of cubic yards of material excavated	334,179
Total linear feet excavated	36,725
Total linear feet of dams constructed of excavated material	63,500
Number of leaning trees removed	8,878
Number of snags removed	604
Number of cubic yards of bowlders removed	321
Number of piles removed	16
unken barge removed	1

Before work of improvement commenced the ruling depth on the bars between Moorhead and the head of Goose Rapids at low water was 1½ feet; and below Grand Forks 2 feet, and the channel between Moorhead and Breckenridge was much obstructed by snags and leaning trees. Since commencing the work of improvement a least depth of 3 feet at ow water has been secured for 80 miles below Moorhead, and of 4 feet or 47 miles below Grand Forks, and no difficulty is now experienced over those improved portions of the river by boats loaded for those depths. In addition, snags and other obstructions have been removed rom the channels for 76 miles above Moorhead to the improvement of navigation at high and medium stages of water

The improvement has resulted in largely increasing facilities for moving grain and merchandise.

Total amount expended on the project to June 30, 1886, including outstanding liabilities, $122,149.97.

July 1, 1885, amount available	$5,571 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,721 82
July 1, 1886, amount available	850 03
Amount appropriated by act approved August 5, 1886	*46,947 65
Amount available for fiscal year ending June 30, 1887	47,797 68
Amount (estimated) required for completion of existing project	56,310 18
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 8.)

9. *Constructing lock and dam at Goose Rapids, Red River of the North, Minnesota and Dakota.*—The original estimate for this proposed work, 1877, was $219,287.99. Object to overcome the fall at the worst obstructions near the head of the rapids, so as to connect with the proposed dredging improvements of the river above and below the rapids.

The acts March 3, 1881, and August 2, 1882, appropriated a total of $50,000 for the work. This sum being small in proportion to the probable cost of the work, and more detailed information in regard to the entire extent of rapids than was at hand being needed, a survey was made during the season of 1883, in order that a close estimate of the cost of improvement might be available for consideration. The report of the survey, which was transmitted to the House of Representatives March 12, 1884, presented three plans, with estimates of cost, as follows:

1. Lock and dams at Buffalo Neck and Isabella Island, and necessary dredging	$481,128
2. Lock and dam at Buffalo Neck, and necessary dredging	274,128
3. Dredging the bars on the rapids and utilizing the dredged material for dams, training-walls, &c	30,000

The report suggested the advisability of substituting an improvement by dredging for that by locks and dams, and the consideration of the advisability of rendering the appropriations already made available for the work of dredging. Should, however, the improvement by a lock and dam with dredged approaches (cost $274,128) be decided upon, the sum of $100,000, in addition to the sums already appropriated, can be profitably expended during the fiscal year ending June 30, 1888, in preliminaries, excavation, foundations, &c.

Amount expended (in examinations) to June 30, 1886, is $3,052.35, which also is the total amount expended.

There are no operations to report for the year ending June 30, 1886.

July 1, 1885, amount available	$46,947 65
July 1, 1886, amount available	†46,947 65
Amount (estimated) required for completion of projected lock and dam, &c.	224,128 49
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 9.)

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* The river and harbor act of August 5, 1886, directs that the money heretofore appropriated for locks and dams on this river be made available for the continuation of the above improvement.

† The river and harbor act of August 5, 1886, directs that the above "amount available" be applied to clearing the river of obstructions.

10. *Reservoirs at headwaters of Mississippi River.*—The object of the reservoirs is to collect surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released, so as to benefit navigation during the season of drought upon the reaches of the several streams below the dams, and also upon that of the Mississippi below Saint Paul. This project may be said to have been adopted in 1880, following an appropriation by Congress for the work by act of June 14, 1880. The system, as originally reported upon, provided for 41 reservoir dams in Minnesota and Wisconsin, at an estimated first cost (omitting that of land, &c., damages) of $1,809,083.

No benefit of consequence can accrue to the navigation of the Mississippi River below Lake Pepin unless the entire system of dams be built.

During the fiscal year construction of the dam on Pine River at the outlet of Cross Lake progressed. The dam will probably be completed by the latter part of August. The reservoir created by this dam has a capacity of 7,000,000,000 of cubic feet.

In addition to the Pine River reservoir dam are three dams completed in 1884, viz: At Lake Winnibigoshish, Leech Lake, and Pokegama Falls. During the low-water season of 1885 the volume of water discharged from the reservoirs created by these dams undoubtedly added from 1 foot to 18 inches to the depth of the Mississippi River at Saint Paul for seventy days. Expended to June 30, 1886, including outstanding liabilities, $568,521.31, which amount includes that awarded to Indians for damages.

The officer in charge calls attention to the numerous private dams at the headwaters of the Mississippi River and its tributaries erected by lumbermen in order to impound water for log-driving, many of the dams being closed from July to the April following, thus depriving the Mississippi of water when it is most needed, the impounded water being liberated in the spring for driving purposes, when the river does not generally need an increase in volume of water. He recommends that the system of reservoirs on the Mississippi River above Minneapolis be completed before extending it in other directions, in order that a full test of the project may be made, and recommends increasing the lift of Pokegama Reservoir by 2 feet, and a survey of Sandy Lake and River with a view to converting the lake into a reservoir.

The sum of $29,500 asked for the fiscal year ending June 30, 1888, to be expended in care and maintenance of dams built, increasing the lift of the Pokegama Reservoir, in survey of Sandy Lake and River, and in securing the title, for reservoir purposes, to about 400 acres of low lands below the Pokegama Reservoir.

July 1, 1885, amount available		$65,256 87
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$46,584 92	
July 1, 1886, outstanding liabilities	2,193 26	
		48,778 18
July 1, 1886, amount available		16,478 69
Amount appropriated by act approved August 5, 1886		37,500 00
Amount available for fiscal year ending June 30, 1887		53,978 69
Amount (estimated) required for completion of existing project		1,186,583 50
Amount that can be profitably expended in fiscal year ending June 30, 1888		29,500 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix Y 10.)

11. *Surveys for reservoirs at the sources of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers.*—The officer in charge reports that if the reservoir work now begun in Minnesota at the headwaters of the Mississippi River is to extend to the Saint Croix, Chippewa, and Wisconsin rivers, it will be necessary, in order to meet questions constantly arising as well as to be enabled to make close estimates of cost of dams, &c., to continue hydrological observations, borings, and contouring of proposed dam-sites. The funds available for these surveys in 1878 and 1879 were not sufficient for a thorough examination of all the region with reference to flowage, so that in estimating areas of land liable to overflow from creation of reservoirs, large margins were necessarily taken on the side of safety. He estimates the cost of examinations for one year at $50,000. There having been no appropriation for such work during the past fiscal year, nothing was done under this head.

Amount (estimated) required for completion of existing project	$50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 11.)

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF CERTAIN RIVERS IN EASTERN TENNESSEE AND KENTUCKY.

Officers in charge, Maj. W. R. King, Corps of Engineers, to March 20, 1886; since which date Lieut. Col. J. W. Barlow, Corps of Engineers.

1. *Tennessee River.*—(*a*) *Above Chattanooga.*—This section, from Chattanooga to Knoxville, a distance of 189 miles, is navigable the greater part of the year. The obstructions are principally rock-reefs, gravel and sand bars, &c.

The present plan of improvement consists of blasting a channel through the reefs, reducing the bars, and building wing-dams to contract the water-way, so as to secure a depth of 3 feet at low water.

No work was done during the fiscal year. Active operations were suspended in October, 1884.

The total amount expended to June 30, 1886, was $218,442.86, which has resulted in the permanent improvement of many of the principal obstructions, and in giving safer navigation and an increased depth of water over the shoals near Knoxville.

The appropriation of August 5, 1886, now made available, and the amount herein asked for can be profitably expended in continuing the work under the existing project, and in repairing and extending the dams already built.

July 1, 1885, amount available		$149 64
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$67 39	
July 1, 1886, outstanding liabilities	25 11	
		92 50
July 1, 1886, amount available		57 14
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,557 14
Amount (estimated) required for completion of existing project		74,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Z 1.)

(*b*) *Below Chattanooga.*—This section of the river is about 456 miles in length. In its original condition from Chattanooga to Brown's Ferry, 162 miles, it was obstructed by reefs, bars, &c., and had about 3 feet of water in channel for nine months in the year; thence to Florence, 39 miles, including the Muscle Shoals obstructions, not navigable. From Florence to mouth of river, 255 miles, there were the usual surface obstructions, with numerous shoals, having navigable pools between them.

The present project consists in building a canal, 14½ miles long, 70 feet to 120 feet wide, and 6 feet deep, around the Big Muscle Shoals, having nine locks, each 300 feet long between gates, and 60 feet wide, and an aqueduct, 900 feet long and 60 feet wide, over Shoal Creek; in constructing a canal, 1½ miles long, with two locks, around Elk River Shoals, and in blasting a channel through the bed-rock and building wing-dams at Little Muscle Shoals; in improving the most dangerous obstructions above Decatur and below Florence.

The total amount expended to June 30, 1886, was $2,689,839.74, which has resulted in the improvement of the river as follows: The Little Muscle Shoals work, as modified, is practically completed; a channel 2½ miles long has been cut through the rock-bed and necessary wing-dams built.

At the Big Muscle Shoals the nine locks are completed, and all the lock-gates except the drop-gates of Locks No. 5 to No. 9 are built. The lower gates of Locks No. 1 to No. 8 are erected, and those of Lock No. 9 are framed and drilled. The upper gates of Locks No. 1 to No. 4 are in position. The masonry of the Shoal Creek Aqueduct is completed, and all the supporting beams are in position, and the drilling and riveting of the steel bottom-plates well advanced. Several permanent bridges and dry rubble protection-dams have been built. The canal-trunk is approaching completion.

At the Elk River Shoals the channel excavation is completed; the masonry of both locks is nearly finished; all the gates are built, and on one lock are placed in position; the excavation of the canal-trunk is well under way.

Several of the most serious obstructions, above Decatur and below Florence, have been greatly improved by the work done at various times since 1868.

The appropriation now available, and the amount herein asked for, can be profitably expended in completing the work of opening the Muscle Shoals Canal to navigation, and in improving the channel below Chattanooga, at the Bridgeport Bar, Tuscumbia Shoals, Colbert Shoals, and other points, also in removing surface obstructions below Florence, Ala.

July 1, 1885, amount available		$120,506 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$105,664 30	
July 1, 1886, outstanding liabilities	9,181 72	
		114,846 02
July 1, 1886, amount available		5,660 26
Amount appropriated by act approved August 5, 1886		262,500 00
Amount available for fiscal year ending June 30, 1887		268,160 26
Amount (estimated) required for completion of existing project		1,175,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Z 1.)

2. *Cumberland River, Tennessee and Kentucky.*—Some work was done by the States of Tennessee and Kentucky about fifty years ago, but without permanent beneficial results.

(*a*) *Below Nashville,* 192 *miles.*—The project for improving this section consists in deepening and widening the channel through rock-reefs and gravel-bars, removing snags, bowlders, &c., and building riprap dams, so as to secure a lengthened season of navigation.

A small working force was employed for a few weeks in clearing the channel between Elk Creek and Line Island, but operations were suspended September, 1885, the available funds being exhausted.

The entire amount expended to June 30, 1886, was $242,359.26, and has resulted in lengthening the season of safe navigation and an improved channel for steamboats drawing 3½ or 4 feet of water, and permitting light-draught boats to run during the low-water season.

The amount herein estimated for can be profitably expended in continuing the work of improving the lower Cumberland, including the bar at its mouth, in accordance with the present project.

July 1, 1885, amount available		$1,588 77
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,303 34	
July 1, 1886, outstanding liabilities	144 69	
		1,448 03
July 1, 1886, amount available		140 74
Amount appropriated by act approved August 5, 1886		12,500 00
Amount available for fiscal year ending June 30, 1887		12,640 74
Amount (estimated) required for completion of existing project		93,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Z 2.)

(*b*) *Above Nashville,* 335 *miles.*—This section now extends from Nashville to the head of Smith's Shoals.

Prior to 1884, the river above Nashville was provided for in the river and harbor acts, under four distinct heads, making an aggregate appropriation of $281,000, all of which has been expended, and has resulted in securing a greatly improved channel, with a lengthened season of navigation, and an increased depth of from 6 to 8 inches of water on the principal obstructions.

The present project consists of building locks at the worst obstructions and dikes upon the sections least obstructed, thus seeking to secure the benefits of both systems, with an expenditure much less than would be obligatory for a complete system of locks.

The amount expended under this plan has amounted to $39,601.75, which has been applied to the improving of the shoals at Upper Nashville Island, by excavation and spur-dams, and in quarrying stone for dams at Priestly's Shoals, an obstruction about 7 miles above Nashville.

The funds that are now available and the amount herein asked for can be profitably expended under the existing plan in channel work and in building locks, beginning with the lowest lock near Nashville.

The engineer officer in charge suggests the advisability of such a subdivision of future appropriations for the river above Nashville as will enable operations to be carried on simultaneously at either end of the proposed system of locks and dams, with a view to giving to each section, as the work progresses, the benefits of an improved navigation.

ly 1, 1885, amount available		$29,060 35
ly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$17,491 44	
ly 1, 1886, outstanding liabilities	1,170 66	
		18,662 10
ly 1, 1886, amount available		10,398 25
ount appropriated by act approved August 5, 1886		75,000 00
ount available for fiscal year ending June 30, 1887		85,398 25
Amount (estimated) required for completion of existing project		3,952,922 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		400,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix Z 2.)

(c) *Above the mouth of Jellico, Kentucky*, 110 *miles.*—No work has been ne on this section since 1882, for the reason given in former reports. The total amount expended on this section is $10,000, which has re-lted in clearing the channel below Pineville of snags, bowlders, and erhanging trees, and reducing gravel-bars, &c.

The principal obstructions remaining are 11 mill-dams, and until these e removed or modified no further work can be done to advantage. A t of these dams is given in Annual Report of Chief of Engineers, 1883.

y 1, 1885, amount available	$5,361 56
y 1, 1886, amount expended during fiscal year, exclusive of liabilities tstanding July 1, 1885	361 56
y 1, 1886, amount available	5,000 00
mount (estimated) required for completion of existing project	40,000 00

ubmitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix Z 2.)

3. *Hiawassee River, Tennessee.*—This river is a tributary of the Ten-see.

he natural channel is chiefly obstructed by bowlders and rock-bars. e overhanging trees falling in during the flood season form snags, d require work from year to year to keep the channel free from these face obstructions.

he present plan is to secure a clear channel 40 feet wide and 2 feet p at low water, from the mouth of the river to Savannah Ford, the d of navigation, about 33 miles.

ork was begun in the channel in August, and continued until Oc-er, when high water stopped operations.

he total amount expended to June 30, 1886, is $30,367.72, and has lted in obtaining an improved channel throughout the 33 miles, as jected, but many of the shoals require much additional work in the erest of safe navigation.

he funds available, and the amount herein asked for, can be profit-y expended in continuing the work of clearing the channel, building essary wing-dams, &c.

, 1885, amount available		2,631 53
1, 1886, amount expended during fiscal year, exclusive of bilities outstanding July 1, 1885	$1,461 51	
1, 1886, outstanding liabilities	37 74	
		1,499 25
1, 1886, amount available		1,132 28
unt appropriated by act approved August 5, 1886		2,500 00
unt available for fiscal year ending June 30, 1887		3,632 28

Amount (estimated) required for completion of existing project	$2,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	2,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 3.)

4. *French Broad River, Tennessee.*—This river rises in North Carolina, and after a course of 121 miles in Tennessee joins the Holston, about 4½ miles above Knoxville, thus forming the Tennessee River.

The present plan consists in removing surface obstructions and in building wing-dams, so as to secure a safe channel having 2½ feet during the low-water season as high as Leadvale (90 miles); above that point the river is not susceptible of improvement, except by slack-water navigation.

The total amount expended to June 30, 1886, is $21,870.20, which has resulted in securing a greatly improved channel and the removal of what had been very dangerous obstructions. The work done has given much satisfaction to river-men generally.

The amount herein asked for could be profitably expended in continuing the work of improvement as projected.

July 1, 1885, amount available		$440 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$261 29	
July 1, 1886, outstanding liabilities	48 91	
		310 20
July 1, 1886, amount available		129 80
Amount appropriated by act approved August 5, 1886		6,000 00
Amount available for fiscal year ending June 30, 1887		6,129 80

Amount (estimated) required for completion of existing project	122,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 4.)

5. *Clinch River, Tennessee.*—This river, about 400 miles long, rising in Virginia, is a tributary of the Tennessee River, and has a course in Tennessee of about 230 miles.

The plan of improvement consists in excavating a clear, wide channel through the ledges and gravel-bars, securing at ordinary low water a depth of 2 feet to Clinton, 70 miles, and at 1½ feet from Clinton to Walker's Ferry, 75 miles; above this point some excavation was done a few years ago in clearing and deepening the channel.

The total amount expended to June 30, 1886, is $20,963.43, and has resulted in securing a greatly improved channel at some of the most dangerous obstructions, and navigation made safe at a stage of water from 2 to 3 feet lower than before the work was begun.

The improvement is practically permanent, and river-men express satisfaction therewith.

The amount herein asked for can be profitably expended in continuing the work as projected.

July 1, 1885, amount available		$110 15
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$27 66	
July 1, 1886, outstanding liabilities	45 92	
		73 58
July 1, 1886, amount available		36 57
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,036 57

Amount (estimated) required for completion of existing project........	$24,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 5.)

6. *Duck River, Tennessee.*—This river is a tributary to the Tennessee River, which it enters about 14½ miles above Johnsonville.

An examination made in 1879 to Centerville, Tenn., about 68 miles, shows that the channel was partly filled, and in some places blocked, by surface obstructions.

The present plan is to remove the snags and overhanging trees, reduce the rock and gravel bars, and build wing-dams where necessary to obtain 3 feet of water, from four to six months of each year.

No work has been done since 1883.

The total amount expended to June 30, 1886, is $13,000, and has resulted in placing the river in fair navigable condition from Cartersville to its mouth.

The amount herein asked for can be profitably expended in carrying on the work under the present project, if Congress deems it advisable to complete the improvement.

Amount (estimated) required for completion of existing project........	$22,118 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 6.)

7. *Caney Fork River, Tennessee.*—This stream flows wholly in the State of Tennessee, and is an important tributary of the Cumberland River, which it enters about 120 miles above Nashville.

It was examined in 1879 to the head of navigation at Sligo Ford, about 80 miles from its mouth. The obstructions were found to be gravel-bars, snags, and overhanging trees, with a crooked channel, having only a few inches of water at many of the shoals, when the river was at a 3-foot stage above low water.

The present plan is to clear, deepen, and straighten the channel, by removing surface obstructions, building wing-dams, &c., so as to obtain safe navigation for about five months in each year, when this river and the Cumberland are at a good boating stage.

No work was done during the fiscal year, the available funds being nearly exhausted.

The total amount expended to June 30, 1886, is $16,569.28, which has resulted in obtaining a greatly improved channel, from its mouth to the head of navigation, when the river is at a stage of about 3 feet above low water.

The amount herein asked for can be profitably expended in continuing the work of improving channel as projected under the existing plan, and in clearing away the snags, logs, &c., that are brought down more or less every year by the heavy floods.

July 1, 1885, amount available	$430 72
July 1, 1886, amount available....................................	430 72
Amount appropriated by act approved August 5, 1886................	3,000 00
Amount available for fiscal year ending June 30, 1887	3,430 72
Amount (estimated) required for completion of existing project........	10,228 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 7.)

8. *Little Tennessee River, Tennessee.*—This stream rises in the Blue Ridge in Georgia, and enters the Tennessee River about 47 miles below Knoxville. An examination was made in 1882 of the lower 13 miles to the mouth of the Tellico River. The obstructions were found to be those common to mountain streams, snags, rock-reefs, bowlders, &c. The present plan is to remove the surface obstructions, and build the wing-dams necessary to obtain at low water a channel 2 feet deep and 40 feet wide, as high as the mouth of Tellico River.

No work was done during the fiscal year, no funds being available.

The total amount expended to June 30, 1886, is $5,000, and has resulted in securing a greatly improved channel, and improving some of the most dangerous shoals. The proposed plan is, however, very far from completion, and the amount asked for can be profitably expended in the manner covered by the existing project.

Amount (estimated) required for completion of existing project	$18,724 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 8.)

9. *South Fork of the Cumberland River, Kentucky.*—This stream is a tributary of the Cumberland River, which it enters near Burnside, Ky.

The obstructions are chiefly reefs, large bowlders, gravel-bars, &c. The present plan is to improve the channel as far up as the Devil's Jumps, about 44 miles, by removing surface obstructions, excavating rock, and building wing-dams, so as to obtain safe navigation when the river is at a 3-foot stage above low water.

No work has been done during the year, the available funds having been nearly exhausted in February, 1885.

The total amount expended to June 30, 1886, is $6,867.30, which has been applied in the improvement of the lower river, principally at Sloan Shoals, and in fitting up the necessary boats, &c.

If Congress deems it desirable to continue the work of improvement the amount herein asked for can be profitably expended in channel work between the Devil's Jumps and the mouth of the river.

July 1, 1885, amount available	$132 70
July 1, 1886, amount available	132 70
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,132 70
Amount (estimated) required for completion of existing project	50,803 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 9.)

IMPROVEMENT OF THE OHIO, MONONGAHELA, ALLEGHENY, AND MUSKINGUM RIVERS.—OPERATING AND CARE OF DAVIS ISLAND LOCK AND DAM, OHIO RIVER, AND LOCK AND DAM NO. 9, MONONGAHELA RIVER.—CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO, AND HARBORS OF REFUGE NEAR CINCINNATI AND AT THE MOUTH OF THE GREAT KANAWHA RIVER.

Officer in charge, Lieut. Col. William E. Merrill, Corps of Engineers, having under his immediate orders First Lieut. George W. Goethals, Corps of Engineers, to August 25, 1885, and First Lieut. Lansing H. Beach, Corps of Engineers, from December 1, 1885, to end of fiscal year.

1. *Ohio River.*—The general method followed in improving the navigation of the Ohio River is to secure additional depths at islands and sand-bars by the construction of low dams closing unused passages or shore dikes confining the water to narrower channels. A snag-boat and two dredges are owned by the United States, and have constant employment during the low-water season in taking out snags and wrecks and dredging away gravel bars that cannot otherwise be removed.

The first appropriation for the improvement of the Ohio River was made in 1827. The total amount thus far appropriated, including the appropriation of August 5, 1886, is $3,770,479.25. In addition to this, there has been allotted to this river a portion of twenty-three different combined appropriations for the Ohio, Mississippi, Missouri, and Arkansas rivers, which aggregated $1,947,000, but the amount thus allotted is unknown.

An outline of the work carried on during the past year is as follows:

Davis Island movable dam.—This dam is 5 miles below Pittsburgh, and forms a pool giving a constant depth of 6 feet above low water in Pittsburgh Harbor. The dam can be lowered to give an open river in high stages of water, and is an experimental structure towards the permanent improvement of the river by a system of movable dams.

The lock was formally opened October 7, 1885, and parts not then completed were finished during the year.

The total cost of the work has been $910,000.

Dike at Merriman.—Work now under contract; dike to be 2,200 feet long. Has been built to a length of 780 feet.

Dam at Black's Island.—A timber apron 500 feet long is to be built below the exposed portion of dam. Work just begun.

Dam at Wheeling Island.—Dam 500 feet long, closing channel behind Wheeling Island. Finished, except a few weeks' work at surfacing.

Dam at Captina Island.—Nearly completed for a length of 1,700 feet, with 300 feet more yet to be built.

Dam at Fish Creek—Partly completed for 1,250 feet. Yet to be built 550 feet.

Dam at Three Brothers Islands.—To be 2,500 feet long. Crib-work completed, but 2,000 cubic yards of riprap yet to go in.

Dike at Sand Creek.—Extended to its full length of 1,485 feet, but the outer 200 feet not ballasted. A spur-dike 150 feet long has been built out from the shore, 200 feet below main dike, to arrest scour.

Dike at Eight Mile.—Finished for a length of 800 feet from the bank, and partly finished for the remaining 1,600 feet.

Dike at Rising Sun.—The full length of 2,700 feet of substructure is completed, and also 120 feet of superstructure.

Improving Grand Chain.—Under the project of reducing the width of the river at the Grand Chain by a series of dikes, two of the three dikes projected have already been built, and the third is now under contract. The substructure of No. 3 is completed for 800 feet and the superstructure partly built for a length of 550 feet. The finished dike will have a length of 3,000 feet.

The effect of the scour caused by these dikes is to wash away the sand from the adopted channel and lay bare the patches of rock that have made this part of the river so dangerous to navigation. In continuing the work, efforts will be directed to blasting out and removing the rock from the channel.

The cost of the three dikes to the end of the fiscal year has been $126,438.97.

Dredging.—Two iron hull dredge-boats built especially for work on the Ohio River, are owned by the United States, but for want of funds both boats remained idle in port at Paducah during the year.

Snagging.—After being lengthened 45 feet, the snag-boat E. A Woodruff came off the docks at South Saint Louis, August 28, and began her season's work August 30, 1885. She worked over the whole length of the river from this time until December 13, when she went into winter quarters at the mouth of the Kentucky River. During the season 513 snags and 3 rocks were removed and 47 wrecks were wholly or partly taken out or destroyed.

Levee at Jeffersonville, Indiana.—The building of this levee has been carried on under a provision in the river and harbor act approved July 5, 1884, allotting "fifty thousand dollars, or as much thereof as may be necessary, for the improvement of navigation of the river at Jeffersonville and the protection of the Government property." The approved project was the construction of a levee 5,818 feet long on the river front of the town of Jeffersonville. This levee is practically completed. A small amount of grading and paving is yet required where the levee is crossed by Meigs avenue, Fulton street, and Mechanic street.

The cost of the work to the end of the fiscal year has been $45,255.74.

Removing obstructions at mouth of Licking River.—This obstruction consists of a limestone ledge, across which there is only about one foot depth of water in low stages of the river. As there is deep water for 2 miles up the Licking, it is proposed to cut a channel through the ledge, giving Ohio River boats access to the many manufacturing establishments along the banks of the Licking not now accessible by boats in low water. The cut will be about 1,500 feet long, 200 feet wide, and 4 feet deep at low water. The estimated cost of the work is $75,000; Amount required to complete project, $56,250.

July 1, 1885, amount available		$395,760 19
July 1, 1885, allotment for improving falls of the Ohio	$6,219 47	
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	303,400 85	
July 1, 1886, outstanding liabilities	32,317 82	
		341,938 14
July 1, 1886, amount available		53,822 05
Amount appropriated by act approved August 5, 1836		375,000 00
Amount available for fiscal year ending June 30, 1887		428,822 05
Amount that can be profitably expended in fiscal year ending June 30, 1888		600,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix A A 1.)

2. *Operation and care of Davis Island Dam, Ohio River.*—The lock and dam were opened October 7, 1885, and have since been in regular use. Some delay has been experienced in working lock gates on account of the breakage of the wheels supporting them. It has been found desirable to have more power for moving the gates, and to make use of steam-power for maneuvering wickets of dam.

The number of steamboats, barges, and miscellaneous craft that passed through the navigable pass from time of opening, October 7, 1885, to the end of the fiscal year was 14,015. Through the lock, 314. Number of lockages, 83.

The total expenses incurred during the year were $8,062.02. Estimated expenses for 1886–'87, $12,015.

(See Appendix A A 2.)

3. *Monongahela River, West Virginia and Pennsylvania.*—No work was done on this improvement during the past year, owing to lack of funds.

The work undertaken on the Monongahela is the extension of the existing slackwater navigation from the mouth of Dunkard Creek to Morgantown, W. Va., a distance of 14 miles. Two locks and dams are required for this extension; No. 9, the upper, is already built, and No. 8, next below, is now in course of construction, with about two-thirds of the lock masonry completed. Sufficient cut stone is already on hand to finish the lock.

The total amount appropriated for this improvement, including the appropriation of August 5, 1886, is $397,900; of this sum $303,275.66 had been expended up to June 30, 1886. The money required for completion is to complete Lock and Dam No. 8, all of which could be expended to advantage during the next fiscal year.

July 1, 1885, amount available	$3,724 34
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	287 38
July 1, 1886, amount available	3,436 96
Amount appropriated by act approved August 5, 1886	90,900 00
Amount available for fiscal year ending June 30, 1887	94,336 96
Amount (estimated) required for completion of existing project	30,376 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,376 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 3.)

4. *Operating and care of Lock and Dam No. 9, Monongahela River.*—New shafts and gear were put in to operate valves for the filling culverts of the lock, and the stony valve was overhauled and adjusted. Face of lock-wall also pointed. The total expenses incurred for the year were $1,064.41. The estimated expenses for 1886–'87 is $1,200.

(See Appendix AA 4.)

5. *Allegheny River, Pennsylvania.*—No funds were available, and no work was done during the past year. Money heretofore appropriated for this river has been expended in removing rocks from the channel and closing low-water chutes behind islands. It is recommended that this work be continued. The estimate given is for this purpose.

Work of improvement on this river was begun in 1879. Total amount appropriated, including appropriation of August 5, 1886, is $135,000; expended to June 30, 1886, $104,365.71.

July 1, 1885, amount available	$634 29
July 1, 1886, amount available	634 29
Amount appropriated by act approved August 5, 1886	30,000 00
Amount available for fiscal year ending June 30, 1887	30,634 29
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 5.)

6. *Dam at Herr's Island, Allegheny River.*—The appropriation of $37,500 under act of August 5, 1886, is the first that has been made for this work. The undertaking is designed to form a navigable pool in

the Allegheny River, opposite the cities of Pittsburgh and Allegheny, by the construction of a lock and dam at the head of the backwater now formed by the Davis Island Dam. This will give increased harbor facilities for the two cities, and be a material benefit to the whole shipping interests of the Upper Ohio River.

Legislation is needed from the State of Pennsylvania, giving the United States the necessary jurisdiction over land required for the structure before any work can be done. It is hoped that this matter will be settled during the coming winter and that the work can be taken up in the spring. The officer in charge calls for the balance of the original estimated cost of the work, since the whole structure can be advantageously put under contract during the next fiscal year.

Amount appropriated by act approved August 5, 1886	$37,500 00
Amount (estimated) required for completion of existing project	115,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	115,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 6.)

7. *Ice-harbor at mouth of Muskingum River, Ohio.*—No money was available for construction, and nothing was done during the year beyond taking care of the property and protecting the work.

The work in hand is the construction of a lock to give Ohio River boats access to Pool No. 1 of the Muskingum River slackwater when ice is troublesome in the Ohio. The lock is somewhat more than half finished, with sufficient uncut stone on hand to complete it. As the old lock, now used to pass boats to and from the Ohio River, is in bad condition, there is an additional demand for the use of the ice-harbor lock by the regular Muskingum River boats.

Including the sum contained in the river and harbor act approved August 5, 1886, the total appropriation for this work amounts to $237,500, and the total expenditure to June 30, 1886, was $199,988.33. The amount that can be profitably expended during the next fiscal year is the estimated amount required to finish the lock.

July 1, 1885, amount available	$836 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	824 96
July 1, 1886, amount available	11 67
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	37,511 67
Amount (estimated) required for completion of existing project	57,633 37
Amount that can be profitably expended in fiscal year ending June 30, 1888	57,633 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 7.)

8. *Muskingum River, Ohio.*—By a clause in the river and harbor act approved August 5, 1886, provision was made for receiving the Muskingum River Slackwater Improvement from the State of Ohio, but at the time when the annual report of Lieutenant-Colonel Merrill was submitted the work had not been turned over to the United States.

This slackwater system is now in operation from the mouth of the Muskingum to Zanesville, Ohio, a distance of 81 miles. In this distance there are eleven locks and ten dams, the dam at Zanesville having a flight of two locks. The lock and dam at Symmes Creek, 4 miles above Zanesville, is out of repair and is not now in use.

The locks and dams below Zanesville are nearly all in need of immediate repair, and it is estimated that the sum of $200,000 will be required to put them in good condition. This sum could be expended to advantage in the next fiscal year. The sum of $20,000, appropriated by the act of August 5, 1886, together with the balance of the State appropriation, will be used for operation and care of work whenever its transfer to the United States shall have been made.

Amount appropriated by act approved August 5, 1886	$20 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	200,000 00

(See Appendix A A 8.)

9. *Operating and care of Locks and Dams on the Muskingum River, Ohio.*—In case the Muskingum River Slackwater is received by the United States, as provided for in the river and harbor act approved August 5, 1886, the expenditures for the fiscal year ending June 30, 1888, are estimated at $37,000.

(See Appendix A A 9.)

10. *Harbor of Refuge near Cincinnati.*—A contract for a third dike at Four-Mile Bar, Ohio River, 10 miles above Cincinnati, is still in force. The dike is finished for a length of 500 feet, but has yet to be raised 4 feet over the remaining distance of 2,000 feet.

The object of this work is to protect the commerce of Cincinnati during winter by catching and holding back ice floes, and secondarily to deepen the water on Four-Mile Bar. Two dikes have been completed and the third is now under construction. The amount expended on the work to the end of the last fiscal year, June 30, 1885, is $79,843.13. No additional appropriation is asked for this harbor.

July 1, 1885, amount available		$19,466 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$16,309 74	
July 1, 1886, outstanding liabilities	3,156 87	
		19,466 61
Amount appropriated by act approved August 5, 1886		11,250 00

(See Appendix A A 10.)

11. *Harbor of Refuge at mouth of Great Kanawha River, West Virginia.*—The work consisted of the construction of three ice-piers in the Great Kanawha River, a little more than a mile above the Ohio River. Two of the piers are on the right bank, at distances of 4,200 and 6,300 feet from the mouth of the river, and the third is on the left bank, at a distance of 6,600 feet. The piers are rectangular in shape and are built to a height of 29½ feet above low water.

The three piers are completed and have already proved of great service to the coal-shippers of the Great Kanawha. No additional funds are required. Total amount expended, $14,831.56.

July 1, 1885, amount available	$10,081 42
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,912 98
July 1, 1886, amount available	168 44

(See Appendix A A 11.)

EXAMINATION AND SURVEY FOR IMPROVEMENTS TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF JULY 5, 1884.

It appearing after preliminary examination that the locality was worthy of improvement by the General Government, Lieutenant-Colonel Merrill was charged with and completed the survey of Muskingum River, Ohio, the report on the results of which were transmitted to Congress and printed as House Ex. Doc. No. 48, Forty-ninth Congress, first session.

(See Appendix A A 12.)

IMPROVEMENT OF THE FALLS OF THE OHIO AND OPERATING AND CARE OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF WABASH AND WHITE RIVERS, INDIANA.

Officer in charge, Maj. Amos Stickney, Corps of Engineers.

1. *Falls of Ohio River, Louisville, Kentucky* (Lieut. Col. William E. Merrill, Corps of Engineers, in charge to March 15, 1886).—The present project was adopted in 1883, the object being the enlargement of the upper portion of the Louisville and Portland Canal and widening of the approach thereto, which practically effects a very considerable enlargement of the harbor of Louisville, Ky.

The amount expended to June, 30, 1886, was $70,533. The material moved to June 30, 1886, was 158,102.5 cubic yards. The work was done under three contracts. Operations were begun July 9, 1885, and carried on during favorable stages of the river until the end of the fiscal year. Work was suspended for nearly four months by reason of high water and bad weather. The earth, loose rock, and river wall are nearly removed from the lower section, and the rock excavation is about half completed to grade. The contractor for the middle section has removed about half the material necessary to clear the rock surface for blasting. Under the three contracts about 245,130.5 cubic yards of material remain to be removed.

The appropriation asked for could be applied to building of north wall and continuation of excavation.

July 1, 1885, amount available		$284,181 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$54,714 41	
July 1, 1886, outstanding liabilities	12,017 18	
		66,731 59
July 1, 1886, amount available		217,449 82
Amount appropriated by act approved August 5, 1886		150,000 00
Amount available for fiscal year ending June 30, 1887		367,449 82
Amount (estimated) required for completion of existing project		885,363 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		300,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix B B 1.)

2. *Indiana Chute, Falls of the Ohio River.*—The object of this work was to improve the navigation of the Falls of the Ohio by straightening and deepening the channels of the middle and Indiana chutes, by building guiding-dikes and removing rock obstructions.

The amount expended to June 30, 1886, was $100,737.85, with considerable benefit to commerce. The work so far is considered a great improvement to the chute, but much remains to be done to give the ease and safety to navigation that is required. But little work was done during the year, owing to a high stage of water.

The appropriation of $30,000 asked for could be applied to continuation of work of rock excavation, repairs of dam, and perhaps a continuation of the crib-work, forming a guiding-dike on the north side of the chute.

July 1, 1885, amount available	$6,219 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,957 32
July 1, 1886, amount available	4,262 15
Amount (estimated) required for completion of existing project	150,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B B 2.)

3. *Louisville and Portland Canal* (Lieut. Col. William E. Merrill, Corps of Engineers, in charge to March 15, 1886).—During the fiscal year the canal was in operation 321 days; it was closed 41 days on account of high water, and 3 days on account of ice.

During the fiscal year 5,057 vessels, representing an under-tonnage of 1,254,342 tons, passed through the canal. The total number of vessels that passed Louisville by canal and river combined was 6,726, representing an under-tonnage of 1,765,497 tons. The work is in fair condition, needing only some minor repairs. The two bridges over the canal were repaired. Small repairs were made to lock-gates and parts of the moving machinery. The dry-dock was put in good order and necessary repairs made to the old dredges and dredge-tender. Three new mud-scows have been built. The new iron dredge hull was received from the contractors, a boiler put in, and the machinery, &c., is being fitted up. Proposals were invited for building a new tow-boat, and contract awarded and executed May 13, 1886. The work is well under way.

The plant for lighting the locks by electricity will probably be procured and placed during the coming year.

The total receipts from all sources will amount to $988.31.

The estimated amount required for operating and maintaining the canal during 1886–'87 is $82,320.

July 1, 1885, amount available on approved project for fiscal year ending June 30, 1886		$91,840 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$64,262 75	
July 1, 1886, outstanding liabilities	5,339 39	
		69,602 14

(See Appendix B B 3.)

4. *Wabash River, Indiana and Illinois* (in charge of Maj. A. M. Miller, Corps of Engineers, to April 10, 1886).—Commerce on this river was greatly interfered with by shoals, snags, logs, and leaning timber blocking the navigable channel. Appropriations for its improvement were first made in 1872, and the project adopted was first the construction of a lock and dam at Grand Rapids, near Mount Carmel, at which place the river is completely cut in two at ordinary stages of water, and the removal of certain rock ledges, sand-bars, snags, leaning timber, and the closing of chutes, the idea being to obtain a navigable channel of 3½ feet in depth from its mouth up to Vincennes.

This river has been separated into two portions in reference to its improvement, the dividing point being Vincennes, Ind., and appropriations were made for each portion.

(*a*) *Below Vincennes.*—In this portion the principal work was the construction of a lock and dam at Grand Rapids, supplemented by the removal of obstructions in the channel and the deepening of the water over bars so as to give 3½ feet in depth at low water.

Previous to July 1, 1880, the appropriations were made to cover the whole river, and up to that time $304,996.19 was expended on the improvement. Since then and up to June 30, 1884, $88,247.74 was expended on the removal of obstructions, and $7,000 for purchase of land, &c., at site of lock and dam at Grand Rapids.

During the fiscal year ending June 30, 1885, $1,756.07 was spent on repairs to New Harmony Dam and removal of obstructions, and $2,824.54 on the lock and dam. During the past year no work except delivery of stone has been done on the river owing to the want of funds. Plant has been laid up under care of watchman.

The amount of expenses for fiscal year ending June 30, 1886, was $12,097.29. The appropriation asked for would be applied to the repair of present works and the construction of the lock at Grand Rapids, and protection of bank to prevent cut off at Grayville.

July 1, 1885, amount available		$27,175 46
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$12,097 29	
July 1, 1886, outstanding liabilities	1,153 57	
		13,250 86
July 1, 1886, amount available		13,924 60
Amount appropriated by act approved August 5, 1886		69,000 00
Amount available for fiscal year ending June 30, 1887		82,924 60

Amount (estimated) required for completion of works indicated	241,600 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B B 4.)

(*b*) *Above Vincennes.*—The project for the improvement of this portion of the river was the removal of obstructions and the construction of wing-dams where necessary.

In addition to the amount, $304,996.19, expended on the whole river to July 1, 1880, $53,021.14 was spent on improving this portion of the river to June 30, 1884. This resulted in giving a fair navigable channel, the principal obstructions having been removed.

During the fiscal year ending June 30, 1885, $8,701.77 was expended, and the work done consisted in the removal of snags and the completion of the dam at Horseshoe Bend. During the past year no work has been done. Plant has been laid up under care of watchmen. Of two dams built, one has attained the object for which it was built and is now in fair condition, needing but few repairs. The other dam, across Horseshoe Cut-off, has proved a failure, the river cutting a new channel around the root of the dam. The channel is 80 feet wide and enlarging. The dam will have to be removed, with the snags and trees in the cut-off, to afford passage for steamboats, navigation being cut in two at low water.

The amount expended during the fiscal year ending June 30, 1886, was $1,901.98. The appropriation of $22,500 asked for would be applied to snagging, repairs of Eight Mile Dam, and to removal of the dam in cut-off at Horseshoe Bend, afterward to dredging, contraction works, and protection of banks.

July 1, 1885, amount available		$3,009 59
September 19, 1885, sale of steamboat Kerasind to another work		1,000 00
		4,009 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,901 98	
July 1, 1886, outstanding liabilities	3 90	
		1,905 88
July 1, 1886, amount available		2,103 71
Amount (estimated) required for completion of existing project		22,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix B B 4.)

5. *White River, Indiana* (in charge of Maj. A. M. Miller, to April 10, 1886).—The project of improvement for this river contemplated the obtaining of a depth of water of 3½ feet at low water. This has been partially obtained from the mouth to Hazleton by means of dikes, a cut in the rock at Kelly's Ripple, and the removal of snags in the channel. The rock cut at Kelly's Ripple, which is the most important of the works, has not yet been completed, but will, after completion, remove the worst obstruction between the mouth of the river and Hazleton Railroad Bridge, where the bad location of the draw prevents any navigation at low water.

The first appropriation was made in 1879, since which date improvements have been carried on. The amount expended to June 30, 1885, was $93,948.58.

During the fiscal year ending June 30, 1886, no work was done beyond watching and taking care of plant.

With the amount asked ($25,000) for the fiscal year ending June 30, 1888, it is proposed to remove snags, dredge some hard gravel bars, and complete the cut at Kelly's Ripple. It is not considered advisable to spend any money on improvements above Hazleton as long as the present railroad bridge remains an obstruction.

July 1, 1885, amount available		$1,051 42
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$637 53	
July 1, 1886, outstanding liabilities	9 08	
		646 61
July 1, 1886, amount available		404 81
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,904 81
Amount (estimated) required for completion of existing project		17,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		17,500 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix B B 5.)

IMPROVEMENT OF GREAT KANAWHA AND ELK RIVERS, WEST VIRGINIA, AND OF NEW RIVER IN VIRGINIA AND WEST VIRGINIA.

Officer in charge, Lieut. Col. W. P. Craighill, Corps of Engineers.

1. *Great Kanawha River, West Virginia.*—This river flows through a fertile and picturesque region, filled with mineral wealth, especially coal and

salt. It was by nature divided into a number of pools, some of considerable length and depth, separated by shoals of gravel and coarse sand, which were the principal obstructions to navigation in low water, there being often on them at such seasons but a few inches of water. In some of the pools were found shallow places also obstructing navigation. There were also snags and loose rock in the channel. The navigation above Charleston was more obstructed than below. Above, it was almost suspended in summer. The coal and salt were generally sent out on rises, which enabled the boats to pass safely over the obstructions that otherwise would stop their movements entirely. The use of the river for the movement of these valuable products was therefore unsatisfactory and intermittent. By the agency and superintendence of a Board acting under the State, first of Virginia and then of West Virginia, considerable improvement in the river was from time to time effected, tolls being charged on the commerce for payment of expenses.

The object of the improvement, begun several years ago by the United States, was to give a constant navigable depth of at least 6 feet throughout the whole length of the Kanawha to its mouth at the Ohio River, to be accomplished by large locks and dams. Those already built have been about 350 by 50 feet in the clear. The peculiarity of most of the dams is that they can be lowered, when the stage of water in the river will suffice, over the shoals. This gives them the name of "movable dams," and enables an open river to be had when the water is high enough.

Dams 3 and 2, both above Paint Creek, are fixed, as the declivity of the river in that section is too great to permit the advantageous use of the movable system. Dam 1 will also be fixed.

Up to June 30, 1885, the amount expended was $1,583,481.54. At that date Lock and Dam 3, 21 miles above Charleston Ferry, had been completed, as also Locks and Dams 4 and 5, respectively 15 and 9 miles above the same point. Lock 6, 4 miles below Charleston, was also completed except the gates, and good progress had been made at Lock 2, 26½ miles above Charleston.

The amount expended in the year ending June 30, 1886, was $145,971.54, which has been applied to Lock 2 and Dam 6. The completion of both is expected before the end of 1886. Lock 2, however, cannot be used until the dam is built, for which at least one more working season will be required.

Had funds been available, all the locks and dams needed for this important improvement could have been begun at the same time and finished in three years, with much economy to the United States, and with manifest advantage in the use of the improved water-way.

The development of commerce on this river has been very great since its improvement by the United States, although the project has been only partially executed, for want of money.

July 1, 1885, amount available		$189 345 01
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$134,298 09	
July 1, 1886, outstanding liabilities	11,673 45	
		145 971 54
July 1, 1886, amount available		43,373 47
Amount appropriated by act approved August 5, 1886		187,500 00
Amount available for fiscal year ending June 30, 1887		230,873 47

Amount (estimated) required for completion of existing project	$1,670,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	500,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix C C 1.)

2. *Elk River, West Virginia.*—The Elk is one of the chief tributaries of the Great Kanawha. Its course is tortuous, as is shown by the fact that the distance from its mouth to Braxton Court-House is 54 miles in a straight line, but 100 miles by the windings of the stream. The average low-water width is about 200 feet, with narrows at the rapids of about 150 feet in width, and occasional portions of about 300 feet in width. The pools vary in depth from 3 to 10 feet, and are separated by rapid shoals of cobble-stones and gravel, on which there has been, at low seasons, a depth of but a few inches of water. The average fall per mile in the river, from Braxton Court-House down, is about 2½ feet, but is not uniformly distributed, being greatest (about 4 feet per mile) in the central section, and less (about 2 feet) in the upper and lower sections. Freshets of small height are of frequent occurrence, but rapidly pass off. The annual rise in the spring is about 10 or 12 feet. An extraordinary rise is sometimes had of 25 or 30 feet, but the duration is not great.

The approved project of improvement has been the removal of rocks, snags, overhanging trees, &c., and the cutting of narrow sluices through the rapids and shoals. The principal interests to be served are those of lumbering and rafting, but much country produce is also carried down stream in small boats, which return with merchandise, &c. The cost of the improvement was originally estimated as $100,000, to make it complete of its kind.

The amount expended from the beginning to June 30, 1885, was $17,000. Nothing has been done in the year ending June 30, 1886, for want of funds. The country through which this stream flows is rich in minerals and well fitted for agriculture and grazing. The improvement already done has been of great benefit to that as yet comparatively undeveloped section.

There are several obstructions to the navigation of this river, due to the action of private parties or corporations, which should be removed if the improvement is to be continued by the United States.

Amount appropriated by act approved August 5, 1886	$1,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix C C 2.)

3. *New River, from the mouth of Wilson, in Grayson County, Virginia, to the mouth of Greenbrier River, West Virginia.*—As has been stated in previous reports, but is here repeated to save trouble in referring to other volumes, the appropriations have been made in such manner as to divide this portion of the river into three sections, as follows:

	Miles.
Upper, or Lead Mines	62
Middle, or New River Bridge	43
Lower, or Greenbrier	86½

Throughout this distance the navigable channel consisted of natural chutes through the ledges and shoals of varying widths, rarely over 1 foot in depth, in some places so tortuous as to render navigation extremely difficult and dangerous.

The original project adopted for the improvement of these natural channels was to widen them to 30 or 50 feet, as might be required, deepen them to 2 feet, and straighten such as needed it. This was for bateau navigation; the improvement, however, to be made in such a manner as to aid the work should a greater depth and width be required in the future.

A small steamboat, draught 12 inches when light, having been built at Hinton in the fall of 1878, rendered it necessary to make the channel in that section 50 feet wide at all points, and in many from 75 feet to 100 feet, the depth of 2 feet being retained. This steamboat was not adapted in dimensions and power to the navigation of the river, and has been withdrawn.

The original plan of improvement has been adhered to, except that the width of channels on the middle and upper divisions has been reduced to 20 feet, and on the former to 10 feet for several miles, to allow iron to be shipped from the furnaces above.

There was no appropriation for this river in 1883, 1884, or 1885. July 1, 1886, there was a balance remaining unexpended of $3,000 from the appropriation of August 2, 1882. This pertained by special designation of the law to the portion of the river above Foster's Falls, which are not passable. The balance remained unexpended because of the impassibility of these falls. As the disconnection with routes of transportation caused by these falls would practically disappear on the completion of the railroad up Cripple Creek, and as boats could then ship to the railroad their freight at Porter's Ferry, above the lead mines and the falls, it was concluded to improve the condition of Williamson's Ledges and Shoals. This work was continued as late as the season allowed, a small balance of funds being left unexpended, but not large enough to justify the resumption of operations in the summer of 1886.

The navigation of the river not being continuous as yet, it is practically a feeder to the railroads which cross it and run along portions of it. It has also been of much use in carrying materials and supplies to the railroads while in process of construction near it. It is probable that when the river is fully improved boats will transport one-third of the products of the fine agricultural country through which it flows, and seven-eighths of those of the mines, exclusive of coal.

July 1, 1885, amount available	$3,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,533 43
July 1, 1886, amount available	466 57
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,466 57
Amount (estimated) required for completion of existing project	159,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C C 3.)

IMPROVEMENT OF KENTUCKY AND TRADEWATER RIVERS, KENTUCKY; OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY; AND OF GUYANDOTTE, LITTLE KANAWHA, AND BUCKHANNON RIVERS, WEST VIRGINIA.

Officer in charge, Capt. J. C. Post, Corps of Engineers.

1. *Kentucky River, Kentucky.*—The present project for the improvement of this river was adopted in 1879, the object being to repair the

five locks and dams built by the State of Kentucky, and extend slackwater navigation for a draught of 6 feet by the construction of additional locks and dams to Beattyville, a distance of 261 miles from the mouth of the river.

Four of the locks have been repaired, three of the dams rebuilt, and the fourth partially repaired during the previous years.

The operations during the past fiscal year have been the reconstruction of Dam No. 5, and the completion of the repairs to the lock, which has extended the slackwater navigation to Oregon, Ky., 99 miles from the mouth of the river. A new keeper's dwelling has been constructed at Lock No. 1, the land has been procured for the dam at Beattyville and its construction commenced, negotiations are about completed for the land for Lock and Dam No. 6, and the repairs upon the snag-boat were partially made. The upper river between the Kentucky Central Railroad Bridge and Beattyville was improved by the removal of obstructions and the construction of wing-walls, &c.

During the present fiscal year the land for Lock and Dam No. 6 will be purchased and the construction of these works commenced. The dam at Beattyville will be completed, as also the repairs to the snag-boat.

July 1, 1885, amount available		$264,721 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$155,641 81	
July 1, 1886, outstanding liabilities	24,186 60	
		179,828 41
July 1, 1886, amount available		84,893 39
Amount appropriated by act approved August 5, 1886		187,500 00
Amount available for fiscal year ending June 30, 1887		272,393 39
Amount (estimated) required for completion of existing project		2,034,139 26
Amount that can be profitably expended in fiscal year ending June 30, 1888		400,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix D D 1.)

2. *Operating and keeping in repair locks and dams on the Kentucky River, Kentucky.*—During the fiscal year the slackwater navigation of the Kentucky River was extended a distance of 17 miles by the completion of Dam No. 5, and the repair of the lock. The up-stream half of Dam No. 4 was also reconstructed, and there is at present slackwater navigation upon the Kentucky River for a draught of 6 feet a distance of 99 miles. Navigation has been continuous except when interrupted by ice and the repairs to Dams Nos. 4 and 5. Two thousand one hundred and ninety-five steamboats, 1,282 barges and flats, 1,936 rafts, and 780 miscellaneous craft passed through the locks, requiring 4,952 lockages. This is a material gain over the amount of navigation reported last year.

The total expenditures to June 30, for the fiscal year, were $26,608.27. The estimated amount required for operating and maintaining navigation for the year 1886–'87 is $33,965, with which it is proposed by the officer in charge to remove by dredging several bars that have been interfering with navigation, and to make the necessary repairs to the locks and dams.

The restoration of the slackwater system in this river has resulted in a very material reduction in freight charges to the various points

During the past year work upon the construction of the lock was continued until October, when it was suspended by the exhaustion of the funds then available. The foundation of the river and miter walls was excavated, and the construction of the walls commenced. About one-seventh of the masonry work of the lock was completed.

Ten per cent. has been added to estimated cost of constructing this work. This has been made necessary by the deterioration of the unfinished work and the natural increase in the expense of conducting a work where operations can only be continued a brief period each year.

During the present season, with the amount now available, the construction of the lock will be advanced as far as practicable, and the improvement of the upper river will be continued.

July 1, 1885, amount available	$15,451 03
July 1, 1886, outstanding liabilities	14,479 99
July 1, 1886, amount available	971 04
Amount appropriated by act approved August 5, 1886	16,875 00
Amount available for fiscal year ending June 30, 1887	17,846 04
Amount (estimated) required for completion of existing project	51,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	26,800 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D D 6.)

7. *Buckhannon River, West Virginia.*—The Buckhannon River empties into the Tygart Valley River, a tributary of the Monongahela River.

The improvement of this river (approved in 1884) contemplates the formation of a channel 24½ miles long, with a minimum width of 30 feet, and a depth of at least 2 feet during an average of four months each year.

When work was commenced this river was practically closed and it was only possible to float out timber during the highest water. The annual amount brought out at that time was about 115,000 linear feet. The result of the improvement already made has increased the amount of timber brought out to over 2,000,000 linear feet, and coal is now being brought to market by river from mines that have been lately opened. The latter, in consequence, has already been reduced materially in price to consumers.

No work was done upon this river during the past year.

With the amount now available the improvement will be continued. It is also proposed to continue it with the amount asked for.

July 1, 1885, amount available		$46 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$8 50	
July 1, 1886, outstanding liabilities	75	
		9 25
July 1, 1886, amount available		37 38
Amount appropriated by act approved August 5, 1886		1,500 00
Amount available for fiscal year ending June 30, 1887		1,537 38
Amount (estimated) required for completion of existing project		22,455 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix D D 7.)

IMPROVEMENT OF THE HARBOR AT DULUTH, MINNESOTA, AND OF THE ENTRANCE TO SUPERIOR BAY—IMPROVEMENT OF THE HARBOR AT GRAND MARAIS, MINNESOTA.

Officer in charge, Maj. Charles J. Allen, Corps of Engineers.

1. *Harbor at Duluth, Minnesota.*—The original project for improvement at Duluth, adopted in 1871, consisted of a breakwater in Lake Superior, outside of Minnesota Point, it being a continuation of a breakwater commenced by the Northern Pacific Railroad Company.

The city of Duluth in 1870 commenced a canal through Minnesota Point to connect the Bay of Superior with the lake. This proceeding was resisted by Superior City on the ground that the canal would divert the waters of the Saint Louis River from the natural entrance and thus deprive it of the current necessary to its maintenance. In 1871 an injunction was issued at the instance of the War Department restraining further operations at the canal, but it was subsequently dissolved upon the execution by the city of Duluth of a bond for $100,000 to secure the construction of a dike to extend from Minnesota Point to Rice's Point, thus isolating the harbor of Duluth from the rest of the Bay of Superior. The dike was completed in 1872, but at present only traces of it are visible.

The act of Congress approved March 3, 1873, appropriated $100,000 for the purpose of dredging out the Bay of Superior from the natural entrance to the docks of Superior and Duluth and preserving both entrances from the lake thereto. This was regarded as legalizing the canal. The outer breakwater was abandoned; the canal and inner harbor rendered it unnecessary. Expended upon original project, $110,000.

Under an allotment of $36,049.20 from the appropriation of 1873, work of improvement commenced upon the inner harbor and canal, the project providing for dredging the harbor, extending and completing the piers bordering the canal, and in making an opening through the dike to provide for the passage of boats from Duluth to Superior, the Government assuming charge of the canal and its piers—work originally undertaken by the city of Duluth. Work under this project continued until 1881, the piers having been kept in repair, the south pier extended, the main harbor area in front of the docks having been enlarged and deepened in part to 16 feet, and a narrow channel dredged along the east side of Rice's Point leading to intersection with the channel of the Saint Louis River. Expended under this project, about $160,651.81

The present project, adopted in 1881, provides for maintaining depths over existing dredged areas, and enlargement of the harbor by dredging to a line joining Rice's and Minnesota points and about 600 feet easterly from the canal, and on lines parallel to Minnesota and Rice's points, the dredging to provide for vessels drawing 16 feet. Estimated cost, as revised in 1884, $305,424.

Work of improvement during the past fiscal year consisted in deepening and enlarging the main harbor in front of the docks, the following-named quantities of material having been dredged:

	Cubic yards.
From the old basin of main harbor	41,476.2
In enlarging the basin of main harbor	21,709.9

Fifty-one and two-tenths cords of stone riprap were placed in the canal at the inner face of south pier to guard against further settling of the substructure of that part of the pier. This part of the pier-work was built by the city prior to the Government assuming charge of the canal.

Expended on the present project to June 30, 1886, including outstanding liabilities, $143,648.67.

The piers are in good condition, a slight settling of the portion of south pier excepted. The ruling depths in the portions of the harbor dredged by the United States are:

	Feet.
In canal	17
In main harbor or basin	16
In Rice's Point Channel to a point opposite Elevator E	16
From point opposite Elevator E, through dredged channel along Rice's Point, to the Saint Louis River	12

The portion of main harbor dredged by the United States has an area of 74½ acres. All the areas and channels above mentioned, canal excepted, require widening.

Before dredging commenced, in 1873, the depth in front of the docks in what is now the main harbor averaged 9 feet; and before adoption of the present project the harbor area was restricted, and there was no channel of consequence along Rice's Point.

The sum asked for the fiscal year ending June 30, 1888, is to be expended in dredging and especially in enlarging the harbor, and in maintenance of the piers.

July 1, 1885, amount available		$12,836 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$11,064 70	
July 1, 1886, outstanding liabilities	23 38	
		11,088 08
July 1, 1886, amount available		1,748 72
Amount appropriated by act approved August 5, 1886		56,250 00
Amount available for fiscal year ending June 30, 1887		57,998 72
Amount (estimated) required for completion of existing project		119,174 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		60,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E E 1.)

2. *Dredging Superior Bay, Wisconsin.*—The original project for improvement, adopted in 1867, consisted in construction of two nearly parallel piers at the entry to connect the deep water of the bay and lake, the piers crossing and bordering a narrow tortuous channel of 8 to 9 feet depth. Work under this project, including scraping between the piers, which increased the depth between them to 10 feet, continued until 1873, at which time the total length of piers was 5,218 feet. Expended under this project, $258,000. In 1873 the project adopted consisted in extension of pier-work and in dredging between the piers and to the wharves of Superior City, the dredging to afford 13 feet of water. The piers were completed in 1874, total length 5,512 feet, the lake ends resting in 16 feet of water and depth of water between the piers not less than 12 feet. From this time until 1881 the work for improvement was almost entirely confined to maintenance of the piers and of portions of Minnesota Point through which waves threatened irruption. A small amount of dredging was done in 1879 near Connor's Point to facilitate passage of light-draught boats between that point and Duluth.

Expended under the second project, $77,513.26, the piers having been extended and kept in repair and Minnesota Point protected. By 1881 the ruling depth from the lake to the wharves was 11 feet.

The present project, adopted in 1881 and modified in 1884, provides for maintenance of piers and beach protection, and for dredging to afford depths of 16 feet, as follows:

Between the piers at the entry.

From the entry along and parallel to the front of Superior City.

Up the Nemadji River for about one-half a mile.

The preservation of the Quebec Wharf Channel was added in 1881, and dredging the channel of the Saint Louis River within the Bay of Superior was added in 1884 by the act of July 5 of that year. This last addition increased the estimate of cost of the project $33,000, thus making it $345,080.

During the past fiscal year dredging was done between the piers in the Saint Louis River Channel and in the Quebec Wharf and Northern Pacific Railroad Dock channels, and necessary repairs made to the north pier at the entry.

Expended under the present project to June 30, 1886, including outstanding liabilities, $99,716.20.

The piers and beach protection are in generally good condition, some slight repairs and extension of beach protection being needed.

The improved channels have the following-named ruling depths:

	Feet.
From Connor's Point to the entry	15
From the Northern Pacific Railroad Dock to the entry	15
In front of Quebec Wharf	12
In the entry between lake ends of piers, the storm of November 6, 1885, having caused some shoaling	16
In remainder of entry	16

Channel at mouth of Nemadji River, narrow with 8 feet depth of water.

All of these channels require widening, and such as do not admit vessels drawing 16 feet of water should be deepened accordingly. The sum of $40,000 asked for the fiscal year ending June 30, 1888, to be expended in maintaining piers and beach protection, in extending the latter, and in widening and deepening the channels between the piers from the entry to Connor's Point, and from the Saint Louis River Channel, within the Bay of Superior, to the Northern Pacific Railroad and Quebec docks.

July 1, 1885, amount available		$13,010 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,660 96	
July 1, 1886, outstanding liabilities	194 77	
		9,855 73
July 1, 1886, amount available		3,154 34
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		25,654 34
Amount (estimated) required for completion of existing project		227,580 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix E E 2.)

NOTE.—The river and harbor act of August 5, 1886, directs that the sum of $9,000 of the above appropriation of $22,500 be applied to dredging in Saint Louis Bay.

3. *Harbor at Grand Marais, Minnesota.*—The project for improvement of this harbor, adopted in 1879 and continued since that time, provided for a breakwater to narrow the entrance and thus to increase the area

of shelter for vessels occupying the harbor, and for dredging to enlarge the anchorage area and to afford depth of 16 feet of water. Estimated cost, $139,669.40. The breakwater was completed in 1883, and dredging was done as appropriations were made for the work.

Grand Marais is on the north shore of Lake Superior, about 110 miles from Duluth, and is the only harbor of refuge for vessels on that rocky coast. It lies within a few miles of the course of American steamers from Duluth to Port Arthur, Ontario, and of the Canadian steamers from Duluth to points beyond Saint Mary's Falls. American tugs are also engaged in the fishing business along the north shore.

Before the work of improvement was begun there was but a narrow space under the lee of Mayhew's Point accessible to vessels drawing 10 feet of water, and the approach to this sheltered space was narrow. Consequently navigators of small vessels had not always confidence in their ability to make the harbor during storms. There is now a sheltered area behind the point, due to dredging operations and to the breakwater, of 8 acres, with least depth of 16 feet. During the past two seasons many vessels have sought shelter in the improved harbor. But in order to bring this harbor up to its maximum usefulness its anchorage area should be enlarged and deepened.

Some slight repairs were made to the breakwater during the past fiscal year.

Total expended on the project to June 30, 1886, $68,045.42.

The sum asked for the fiscal year ending June 30, 1888, is to be expended in dredging and maintenance of breakwater.

July 1, 1885, amount available	$2,493 87
July 1, 1886, amount expended during fical year, exclusive of liabilities outstanding July 1, 1885	539 29
July 1, 1886, amount available	1,954 58
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	11,954 58
Amount (estimated) required for completion of existing project	59,669 40
Amount that can profitably be expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E E 3.)

HARBORS ON LAKE SUPERIOR (EAST OF SUPERIOR CITY), ON GREEN BAY, AND ON THE WESTERN SHORE OF LAKE MICHIGAN, NORTH OF MILWAUKEE, WISCONSIN.

Officers in charge, Lieut. Col. J. W. Barlow, Corps of Engineers, to March 10, 1886; Capt. W. L. Marshall, Corps of Engineers, from March 10 to May 24, 1886; and Capt. Charles E. L. B. Davis, Corps of Engineers, since that date.

1. *Ontonagon Harbor, Michigan.*—Previous to the improvement of this harbor the channel of the river's mouth was but 7 feet deep at the shoalest place, and the shifting nature of the lake-bottom caused frequent changes in its position.

The project of constructing piers extending from each bank of the river's mouth lakeward to the 18-foot curve, and dredging a channel not less than 12 feet deep between them, was adopted in 1867.

The total expenditure, amounting to $270,374.70, of which $70.40 was expended during the past fiscal year, has resulted in the construction of an east pier 2,265 feet in length, and a west pier 2,375 feet in length, and the removal by dredging of 10,546 cubic yards of sand from the outer bar, forming a channel 100 feet wide at its narrowest point, with a depth of about 12 feet at low water.

This is an important harbor, especially for refuge, affording the only shelter obtainable between the Apostle Islands and the Portage Lake Canal entrance, and the latter is difficult of access in bad weather.

The appropriation asked for the fiscal year ending June 30, 1888, is for further pier extension and possibly repairs.

July 1, 1885, amount available	$2,295 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	70 40
July 1, 1886, amount available	2,225 30
Amount appropriated by act approved August 5, 1886	13,000 00
Amount available for fiscal year ending June 30, 1887	15,225 30
Amount (estimated) required for completion of existing project	78,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 1.)

2. *Eagle Harbor, Michigan.*—Previous to the improvement of this harbor the entrance was obstructed by a rocky reef, having about 9 feet of water over the shoalest point.

The project of improvement was adopted in 1866, and modified in 1868, 1874, and 1877, and consisted in blasting and dredging a channel 130 feet wide and 14 feet deep through the reef. The work was completed in 1879. The channel is now marked by a guiding-crib on each side, and meets the present demands of commerce. As stated in the last annual report, the channel was obstructed by a number of bowlders, which reduced its available depth in places to 12 and 13 feet, and their removal was in progress at the beginning of the fiscal year. The work was completed July 11, 1885.

The total expenditure to June 30, 1886, is $94,113.67.

No appropriation is asked for this harbor, as the funds on hand will probably be sufficient to cover the expenses of keeping the channel and piers in good condition for several years.

July 1, 1885, amount available	$3,213 84
July 1, 1386, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	327 51
July 1, 1886, amount available	2,886 33

(See Appendix F F 2.)

3. *Marquette Harbor, Michigan.*—In its original condition, no protection was afforded to vessels at this harbor during the prevalence of easterly and northerly gales.

In 1866 a project of improvement was adopted, which consisted in the construction of a crib-breakwater 2,000 feet in length and 25 and 40 feet in width, built to a height of 6 feet above water, at an estimated cost of $385,129.58. Under a modification of this project the width was reduced to 20, 25, and 30 feet, and the structure was completed in accordance therewith in 1875, the total length being 2,010 feet, and the total cost $290,646.55.

The total expenditures to June 30, 1886, were $308,166.48.

No work was done during the year, but arrangements were made for delivering and placing 150 cords, more or less, of stone required as riprap near the outer end of the breakwater, which will probably be done in July. It is probable that some repairs will also be required this season to the superstructure.

The breakwater now affords an excellent protection for a limited number of vessels during bad weather; but further protection should be afforded to provide the necessary anchorage room for the largely increased business now being carried on at this port.

An extension of the breakwater 400 feet has been recommended, at an estimated cost of $68,000, but this is now deemed insufficient for the prospective needs of this harbor, a much greater extension than this, or an additional detached work, being required.

It is proposed to retain the funds now on hand, except such as may be needed for repairs, until a sufficient amount shall have been appropriated with which to build either an extension to the present breakwater or a new structure, as may then be considered most expedient.

July 1, 1885, amount available	$11,616 08
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	552 50
July 1, 1886, amount available	11,063 58

(See Appendix F F 3.)

4. *Harbor of Refuge, Grand Marais, Michigan.*—The object of this improvement is to provide a harbor of refuge for vessels navigating Lake Superior. The project was adopted in 1881, on the recommendation of a Board of Engineer Officers, and consists in the formation of an artificial entrance to the harbor by the construction of two parallel crib-piers 500 feet apart, and dredging a cut through the sand-spit north of the harbor and between the piers to make a channel 300 feet wide and 18 to 20 feet deep, connecting the deep water of the lake with the deep water of the natural harbor. Originally the channel was variable, with a depth of not more than 6 feet.

Under contract dated September 17, 1884, during the past fiscal year the west pier was extended 250 feet, the east pier 150 feet, and the contract completed. By hired labor and purchase of materials in open market, the east and west piers were each extended 100 feet shoreward to prevent the waves from cutting sand away from the inner ends of the piers.

The total expenditures since the beginning of the improvement amount to $100,856.38, of which sum $27,621.71 have been expended during the fiscal year ending June 30, 1886.

The west pier now consists of 1,000 feet of crib-work and 100 feet of pile-dike, and the east pier of 750 feet of cribs and 100 feet of pile-work. Thirty-two thousand one hundred and four cubic yards of material have been removed by dredging.

The importance of completing this work at an early day can hardly be overestimated; and the interests of the lake marine, representing as it does millions of dollars, would seem to justify large appropriations annually until the harbor is completed.

July 1, 1885, amount available	$31,765 3
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	27,621 71
July 1, 1886, amount available	4,143 6
Amount appropriated by act approved August 5, 1886	26,250 0
Amount available for fiscal year ending June 30, 1887	30,393 6

Amount (estimated) required for completion of existing project..........	$318,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 4.)

5. *Manistique Harbor, Michigan.*—This harbor is at the mouth of Manistique River. The natural channel of entrance to the mouth of the river was 7 feet deep. By private enterprise 3,000 linear feet of slab-pier was built at the mouth of the river, and the channel was dredged to a depth of 10 feet previous to any appropriation having been made by the Government.

By the acts of 1880 and 1881 the sum of $6,000 was appropriated for this harbor, in order to dredge a channel 150 feet wide and 12 feet deep between the piers built by a local lumbering company. Dredging was done to the amount of 11,780 cubic yards, and the work was then suspended in consequence of the refusal of the company controlling the harbor to rectify their pier-lines when rebuilding the same.

No work has been done during the year.

No appropriation is asked for this harbor.

July 1, 1885, amount available..	$3,501 79
July 1, 1886, amount available..	3,501 79

(See Appendix F F 5.)

6. *Harbor at mouth of Cedar River, Michigan.*—The project of improvement consists in the construction of two parallel piers 200 feet apart, extending from the mouth of Cedar River to the 16-foot curve in Green Bay, with dredging outside the shore lines between the piers sufficient to make a channel 14 feet deep at low water, extending to the deep water in Green Bay.

Fifteen thousand dollars was appropriated by act of Congress passed August 2, 1882, toward carrying out this project, and a second appropriation of $15,000 was made July 5, 1884.

At the begining of the fiscal year ending June 30, 1886, work had just begun under contract dated November 4, 1884. Under this contract the east pier was extended 200 feet, and the west pier begun and built to a length of 300 feet, and contract closed November, 9, 1885.

The expenditures during the year have amounted to $10,517.06, and the total expenditures since the beginning of the improvement amount to $27,329.98.

The east pier is now 753 feet in length and terminates in 9 feet depth of water; the west pier 300 feet long with a depth of 5 feet of water at its outer end. Soundings made in October, 1885, showed a channel about 50 feet in width 13 feet deep, and 100 feet in width 11 feet deep.

The interests at this harbor are of a local character, the business, which consists in the manufacture and shipment of lumber, being confined at present to a single saw-mill. It is not important that the improvement of this harbor be continued at present, and no appropriation is asked for the fiscal year ending June 30, 1888.

July 1, 1885, amount available..	$13,187 08
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885..	10,517 06
July 1, 1886, amount available..	2,670 02
Amount (estimated) required for completion of existing project..........	108,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 6.)

7. *Menomonee Harbor, Michigan and Wisconsin.*—Previous to the improvement of this harbor the natural channel was obstructed by a bar opposite the mouth of the Menomonee River, over which there was a depth of only 6 feet of water.

The project of improvement was adopted in 1871 and modified in 1874, its object being to afford a navigable width of channel not less than 14 feet deep, by pier-extension and dredging.

During the fiscal year ending June 30, 1886, no work was done. The expenditures during the year, $524.05, have been applied, mainly, to fitting out and repairing the dredges and tug. The total expenditure since the beginning of the improvement is $196,869.83.

The north pier is completed in accordance with the existing project, having a length of 1,854 feet, and terminating in 16 feet depth of water, and the south pier is 2,710 feet in length and extends 100 feet beyond the outer terminus of the north pier, but must be continued 350 feet further to attain the same depth of water.

There have been 205,828 cubic yards of material removed from the channel by dredging. There is a 12-foot channel between the piers not less than 150 feet wide. A shoal spit of about 11 feet depth has been forming in advance of the south pier and now extends 280 feet beyond it.

It is proposed to improve the channel by dredging to the extent of available funds, with the United States dredges, during the present working season.

The appropriation asked for the year ending June 30, 1888, is for further pier extension.

The piers are extensively used by a lumber company for storing and handling lumber and for mooring vessels. Such use is injurious and should be discontinued.

July 1, 1885, amount available	$3,654 22
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	524 05
July 1, 1886, amount available	3,130 17
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	6,130 17
Amount (estimated) required for completion of existing project	9,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 7.)

8. *Oconto Harbor, Wisconsin.*—In its natural condition the channel at the entrance to Oconto River was obstructed by a bar with less than 2 feet of water over it. Previous to 1881, when the first appropriation was made for its improvement, the citizens had, by the construction of a small amount of slab-pier, and by dredging, increased the depth to 3½ feet.

The project of improvement proposes to secure an 8-foot channel from deep water in Green Bay to the city of Oconto by dredging and the construction of piers, at an estimated cost of $150,000.

During the year ending June 30, 1886, a pile protection 1,000 feet long for the south pier was finished by the placing of 120 feet of wales; the south pier was extended 301 feet, and the north pier 503 feet, under contract dated September 12, 1884.

By hired labor and the use of a United States dredge 30,529 cubic yards of material were removed, and minor repairs were made to the south pier.

The north pier is now 1,603 feet in length. The south pier is 2,151 feet long, the full length contemplated by the approved project, and 141,980 cubic yards of material have been removed by dredging.

The total amount expended to June 30, 1886, is $39,897.49, of which amount $11,065.92 was expended during the last fiscal year.

The navigation interests at Oconto are at present dependent upon the business of three lumber companies located there, and the benefits to be derived are essentially local.

The officer in charge recommends a modification in the project, so as to restrict the work to be done under Government appropriations to the part outside the shore-line, as is customary at other lake harbors; and as the outside improvement will be of little value without the other, he suggests that the further application of funds to this work be contingent upon a proper improvement of the channel inside the shore-line by local authority.

July 1, 1885, amount available	$11,168 43
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,065 92
July 1, 1886, amount available	102 51
Amount appropriated by act approved August 5, 1886	8,000 00
Amount available for fiscal year ending June 30, 1887	8,102 51
Amount (estimated) required for completion of existing project	102,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 8.)

9. *Pensaukee Harbor, Wisconsin.*—The first appropriation for this harbor was made in 1882. At that time the facilities of the natural channel had been increased by private enterprise from a depth of 2 feet of water to a depth varying from 7 to 9 feet, for a width of 30 feet, by the construction of 1,600 linear feet of continuous slab-pier and by dredging.

The project of improvement is for the extension of this 1,600 feet of pier a distance of 2,500 feet further, and the formation of a channel 100 feet wide and 10 feet deep from the bay to the harbor, at an estimated cost of $50,000.

The total amount expended to June 30, 1886, is $10,552.08, of which $1,328.83 was expended during the last fiscal year.

There have been built 1,300 feet of the proposed extension of the pier, and 5,698 cubic yards of material have been dredged, making a channel 25 feet wide and 10 feet deep at low-water. The entire length of the pier was 2,900 feet, the inner 1,600 feet having been built by private parties, and the remaining 1,300 linear feet having been built by the United States.

A severe storm, September 8 and 9, 1885, carried away some 1,200 feet of the pier built by private parties, filled up or obstructed a large portion of the channel, and caused some injury to the Government pier, which latter was repaired.

The officer in charge having reported that there are at present no commercial or navigation interests to be benefited by improving this harbor, and that it is not necessary as a harbor of refuge, and having recommended that further expenditure upon its improvement be deferred until more satisfactory evidence of the necessity of the work is received, with the concurrence of the Chief of Engineers in this opinion, the recommendation was submitted to the Secretary of War, and approved by him.

July 1, 1885, amount available	$5,775 75
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,328 83
July 1, 1886, amount available	4,446 92

Amount (estimated) required for completion of existing project	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 9.)

10. *Green Bay Harbor, Wisconsin.*—Before the improvement of this harbor was begun the channel between the mouth of Fox River and the deep water in Green Bay was circuitous and narrow, with but 6 feet of water at its shoalest point.

The project of improvement was adopted in 1866 and modified in 1872 and 1881, its object being to secure a channel 200 feet wide, 14 feet deep, and 2 miles long, in place of the natural channel, including a revetted cut across Grassy Island.

During the past fiscal year 11,500 cubic yards of material were removed from the channel by dredging under contract; and by hired labor and purchase of material in open market the superstructure of the east revetment at Grassy Island (705 linear feet) was entirely rebuilt, $8,812.84 being expended.

The total expenditures since the beginning of the improvement amount to $270,507.90, resulting in a dredged channel 10,600 feet long, 200 feet wide, and 14 feet deep, except where occasional shoals reduce the depth to 13 feet, and the construction of 1,325 linear feet of pile and timber revetment on the sides of the cut through Grassy Island.

The appropriation asked for the fiscal year ending June 30, 1888, will be applied to dredging and repairs.

July 1, 1885, amount available	$8,854 94
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outsanding July 1, 1885	8,812 84
July 1, 1886, amount available	42 10
Amount appropriated by act approved August 5, 1886	7,000 00
Amount available for fiscal year ending June 30, 1887	7,042 10

Amount (estimated) required for completion of existing project	30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 10.)

11. *Harbor of Refuge at entrance of Sturgeon Bay Canal, Wisconsin.*—Before the construction of this harbor was undertaken the location afforded no shelter at all from storms ranging from northeast to southwest.

The project of constructing a harbor of refuge at this point was adopted in 1873 and modified in 1879 and 1880. The modified project provides for the construction of two piers, each 1,200 feet long, 850 feet apart at the shore-line, protecting the lake entrance to the canal, and converging so as to make the harbor entrance 235 feet wide, and to inclose an area of about 10 acres.

During the fiscal year ending June 30, 1886, the United States dredges removed 30,940 cubic yards of material from the harbor, $2,580.82 being expended.

The total expenditure at this harbor since the beginning of the improvement has been $157,794.42, resulting in the entire completion of the piers as projected and in the dredging out of 121,099 cubic yards of material, affording a channel 16 feet deep and over 100 feet wide from the lake to the entrance of the canal, and making 14 feet depth over the greater part of the remainder of the sheltered area.

The amount asked for the fiscal year ending June 30, 1888, will be expended in dredging and repairs.

July 1, 1885, amount available	$4,786 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,580 82
July 1, 1886, amount available	2,205 58
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	7,205 58
Amount (estimated) required for completion of existing project	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 11.)

12. *Ahnapee Harbor, Wisconsin.*—Previous to the improvement of this harbor the depth of water at the river mouth was only about 2 feet. The project of improvement adopted in 1875 and modified in 1884 provides for the formation of a small artificial harbor and a channel with not less than 12 feet of water, by the construction of piers and dredging.

During the past fiscal year there have been no operations except the removal, by one of the United States dredges, of about 20 cubic yards of loose rock from two shoal places in the channel. The amount expended was $818.69.

The total expenditures on this improvement to June 30, 1886, have been $139,498.61, resulting in the construction of 900 linear feet of north pier and 1,125 feet of south pier, 250 feet of superstructure being yet unbuilt, and in the removal of about 22,220 cubic yards of rock and 82,343 cubic yards of sand and mud, making a channel of 50 feet width and over, with a depth of not less than 10 feet at low water.

The appropriation desired for the fiscal year ending June 30, 1888, will be applied to pier extension and removal of rocks and sand.

July 1, 1885, amount available	$1,320 08
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	818 69
July 1, 1886, amount available	501 39
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,501 39
Amount (estimated) required for completion of existing project	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 12.)

13. *Kewaunee Harbor, Wisconsin.*—The natural entrance to this harbor was via Kewaunee River. The river mouth was not more than 20 feet wide, with a depth of about 2 feet at its shoalest point, and obstructed by submerged bowlders.

The project of improvement was adopted in 1881. Its design was to cut a channel through a neck of land between the river and the lake at a point about 2,000 feet south of the river mouth, and to continue this channel to deep water in the lake by the construction of two parallel piers 200 feet apart, extending from each side of the cut lakeward to the 18-foot curve.

During the fiscal year ending June 30, 1886, under contract dated September 12, 1884, the south pier was extended 500 feet. By hired labor the United States dredges removed 116,976 cubic yards of material. The amount expended was $17,290.58.

The total amount expended to June 30, 1886, is $34,936.67, in addition to which the Harbor Commissioners have expended $8,042.72. These expenditures have resulted in the construction of 700 linear feet of a north pile-pier and 775 linear feet of a south pile-pier, and in the dredging of a new channel 125 feet wide and 12 feet deep, in accordance with the approved project.

The appropriation asked for the fiscal year ending June 30, 1888, will be applied mainly to pier extension.

July 1, 1885, amount available	$17,353 91
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	17,290 58
July 1, 1886, amount available	63 33
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,063 33
Amount (estimated) required for completion of existing project	146,957 23
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 13.)

14. *Two Rivers Harbor, Wisconsin.*—Previous to the improvement of this harbor the natural channel was obstructed by a bar covered by but 2 or 3 feet of water.

The project of improvement adopted in 1870 provided for the formation of a channel of navigable width and not less than 12 feet deep. This was to be accomplished by the construction of two piers extending from the river mouth lakeward to the 18-foot curve, and by dredging.

During the year ending June 30, 1886, 26,663 cubic yards of material were dredged from the channel, 345 linear feet of sand-fence built, and minor repairs made to the north and south piers, the amount expended being $3,069.74.

The total expenditures to June 30, 1886, were $197,864.67, resulting in the construction of two parallel piers, as follows:

A north pier 1,810 feet long, the inner 1,060 linear feet of which consists of pile-pier, and the outer 750 feet of crib-pier; a south pier 1,710 feet long, 960 linear feet of which is pile-pier, and the outer 750 feet crib-pier. The crib sections of the two piers begin at points opposite, and are 230 feet apart. The pile sections are 270 feet apart; 240,600 cubic yards of material have been removed by dredging. The channel is 12 feet deep for a width of about 180 feet.

The appropriation asked for the year ending June 30, 1888, is for the maintenance of the channel and piers.

July 1, 1885, amount available	$3,205 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,069 74
July 1, 1886, amount available	135 33

Amount (estimated) required for completion of existing project	67,588 80
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 14.)

15. *Manitowoc Harbor, Wisconsin.*—Previous to the improvement of this harbor but 3 feet of water existed at the shoalest point over the bar at the mouth of the river.

The project of forming a channel of not less than 14 feet depth by the construction of parallel piers extending from the river mouth lakeward, and by dredging between them, was adopted in 1866, and modified in 1872 and 1881.

During the fiscal year ending June 30, 1886, the plank walk of the north pier was repaired. The amount expended during the year was $717.82.

The total expenditures to June 30, 1886, amounting to $276,098.57, have resulted in the construction of a north and south crib-pier 1,970 and 1,650 feet long, respectively, 228 feet apart at the shore-line and 250 feet apart at the outer ends, and in the dredging of a channel, which is now 150 feet wide and 14 feet deep.

The appropriation asked for the fiscal year ending June 30, 1888, is to be applied to pier extension, rebuilding superstructure, and dredging, if needed.

July 1, 1885, amount available	$1,439 25
Amount received from sale of fuel to officers	80 50
	1,519 75
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	717 82
July 1, 1886, amount available	801 93
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,801 93
Amount (estimated) required for completion of existing project	16,362 54
Amount that can be profitably expended in fiscal year ending June 30, 1888	16,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 15.)

16. *Sheboygan Harbor, Wisconsin.*—Previous to the improvement of this harbor the natural channel had a depth not exceeding 4 feet on the bar at the entrance to the river.

The project adopted had for its object the formation of a 12-foot channel by the construction of piers and dredging. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost, and a channel was formed 100 feet wide with a depth of 15 to 16 feet between the piers. The existing project was adopted in 1881, its object being to deepen the channel still further by extending the piers to the 20-foot curve and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore line.

During the fiscal year ending June 30, 1886, under contract dated March 20, 1885, the south pier was extended 350 linear feet by sinking seven cribs on pile foundations and completing the superstructure over the same. The superstructure upon 95 feet of the pier adjoining the new work which had settled was also built up to the proper height. The amount expended during the year was $21,271.71.

The total expenditures to June 30, 1886, have amounted to $273,446.69, and have resulted in the construction of a north and south pier, 1,844 and 2,260 feet long, respectively, built of cribs (except less than 300 feet at the shore end), of widths from 14 to 20 feet, and in dredging 172,558 cubic yards of material from the channel.

In June of this year there was a narrow but available channel of 13¼ feet depth to the inner harbor.

The only means of securing a permanent channel is by the rapid extension of the piers to deep water; hence a liberal appropriation is urged as a matter of economy and of necessity to the commerce of this important harbor.

The appropriation asked for the fiscal year ending June 30, 1888, will be applied to pier extension and repairs to the south pier, and dredging if needed.

July 1, 1885, amount available	$21,273 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	21,271 71
July 1, 1886, amount available	2 22
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,002 22
Amount (estimated) required for completion of existing project	97,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix F F 16.)

17. *Port Washington Harbor, Wisconsin.*—The natural channel at the mouth of the Sauk River was narrow, and at the shoalest point had a depth of but 1 foot.

The project for the improvement of the harbor, adopted in 1869 and modified in 1870 and 1876, was for the formation by dredging of two interior basins, having a combined area of about 5¾ acres, with a depth of 12 feet, and a channel of the same depth connecting them with the lake, the channel entrance to the basins to be north of the mouth of the Sauk River, inclosed between two piers, so constructed that the flow of the river should be separated from the channel, and that the débris brought down by freshets, instead of shoaling the channel, should reinforce the south pier.

During the fiscal year ending June 30, 1886, $2,370.78 have been expended in removing from the channel 10,681 cubic yards of material by the United States dredges, making a depth of not less than 12 feet, with a width varying from 35 to 110 feet, and in riprapping the north and south piers.

Up to June 30, 1886, $164,489.39 had been expended in this improvement in constructing a north and south pier, respectively, 870 and 1,226 feet in length, including about 400 linear feet of revetment along the north bank of the river, extending to the inner end of the south pier; also in the formation by dredging of two interior basins, with an area of 2¾ and 3 acres, respectively, with an available depth of from 8 to 12 feet, and in making a channel 60 feet wide and 12 feet deep, extending between the piers from the basins to the lake.

The appropriation asked for the year ending June 30, 1888, is for the purpose of completing the project and making necessary repairs to the old work.

July 1, 1885, amount available	$2,381 39
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,370 78
July 1, 1886, amount available	10 61
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,010 61
Amount (estimated) required for completion of existing project	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 17.)

EXAMINATION AND SURVEY FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF JULY 5, 1884.

Ashland Harbor, in Ashland Bay, Lake Superior.—The preliminary report upon this harbor, and a report upon a survey with the view to its improvement, were transmitted to Congress and printed in House Ex. Doc. No. 89, Forty-eighth Congress, second session, and also in the Report of the Chief of Engineers for 1885, page 2010.

For a subsequent report from Lieut. Col. J. W. Barlow, Corps of Engineers, of the results of a survey made in June, 1885, to ascertain the proper location for a breakwater, and to prepare estimates of its cost, see Appendix F F 18.

CONSTRUCTION OF HARBOR OF REFUGE, MILWAUKEE BAY—IMPROVEMENT OF THE HARBORS OF MILWAUKEE, RACINE, KENOSHA, AND WAUKEGAN—IMPROVEMENT OF FOX AND WISCONSIN RIVERS.

Officer in charge, Capt. W. L. Marshall, Corps of Engineers, with Lieut. G. D. Fitch, Corps of Engineers, under his immediate orders.

1. *Harbor of Refuge, Milwaukee Bay, Wisconsin.*—The project for this work was approved in 1881, and contemplated the formation of an artificial harbor by inclosing a portion of Lake Michigan within an outer breakwater of crib-work upon a stone foundation. This harbor will furnish 417 acres of safe mooring ground beyond the 18-foot curve and about twice this area beyond the 12-foot curve.

Work was begun in 1881, and up to June 30, 1886, there has been expended $277,199.86, resulting in the completion of 3,100 feet of the substructure and 2,450 linear feet of the superstructure of the breakwater.

During the fiscal year ending June 30, 1886, the east arm of the breakwater was extended 50 feet, and the superstructure completed over 1,600 linear feet of breakwater.

The breakwater when completed will be 7,250 feet in length; there remains then to be constructed 4,150 linear feet of substructure and 4,800 linear feet of superstructure to complete the work.

The small balance of appropriation now available is sufficient only to maintain the required light at the end of the breakwater during the present season of navigation.

The funds asked for the fiscal year ending June 30, 1888, are to be applied to the extension southward of the east arm of the breakwater.

The harbor has now begun to be used as a harbor of refuge to a limited extent for vessels during northeast storms. Its value will rapidly increase as the east arm is extended.

July 1, 1885, amount available	$29,160 43
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	27,421 81
July 1, 1886, amount available	1,738 62
Amount appropriated by act approved August 5, 1886	60,000 00
Amount available for fiscal year ending June 30, 1887	61,738 62
Amount (estimated) required for completion of existing project	455,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	150,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 1.)

2. *Milwaukee Harbor, Wisconsin.*—The present project was adopted in 1852, and was directed to securing 12 feet of water at the entrance to the river and to protecting this channel by parallel piers. Since that date a channel, 18 feet in depth and of sufficient width, has been formed by extending the piers and dredging. The project has been completed, and consequently the only expenditures now demanded are for the maintenance of the piers by timely repairs and the depth of the channel by dredging.

The original depth of water at the mouth of the river was not more than 3½ feet.

The United States has expended on this harbor up to June 30, 1886, $276,110.27, in addition to $321,355.66 by the city of Milwaukee.

During the fiscal year ending June 30, 1886, no work has been done upon this harbor.

The superstructure of the piers is in urgent need of rebuilding, but the funds now available are insufficient even to begin the work with advantage.

The present available funds and the money asked for the fiscal year ending June 30, 1888, are to be applied to the maintenance of the present piers and channel, and to the rebuilding the superstructure over the north and south piers, built in 1871–'72.

July 1, 1885, amount available	$9,690 89
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	952 99
July 1, 1886, amount available	8,737 90
Amount (estimated) required for completion of existing project	22,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 2.)

3. *Racine Harbor, Wisconsin.*—The entrance to this harbor originally varied in depth from absolute closure after storms to about 6 feet.

The present project was adopted in 1843, and contemplated originally a channel 12 feet in depth. The piers have since been further extended and the channel deepened to 16 feet by dredging.

There has been expended upon this harbor up to June 30, 1886, $221,189.

During the fiscal year ending June 30, 1886, a contract was made for dredging the channel, which had deteriorated to 13 feet, to restore its depth to 16 feet, which work is now in progress, two dredge-cuts the entire length of the piers having been made up to the close of the fiscal year.

The funds now available will be required and used under this contract.

The funds asked for the fiscal year ending June 30, 1888, are to be applied to the extension of the south pier, as explained in the Annual Report of the Chief of Engineers for 1883, and to rebuilding parts of the superstructure of the piers. The pier extension is not urgent, but the repairs to the piers are now necessary, which will require an appropriation of $10,000.

July 1, 1885, amount available		$3,582 18
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$731 96	
July 1, 1886, outstanding liabilities	1,732 72	
		2,464 68
July 1, 1886, amount available		1,117 50
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		11,117 50
Amount (estimated) required for completion of existing project		25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix G G 3.)

4. *Kenosha Harbor, Wisconsin.*—The present plan of improvement by parallel piers and dredging was first directed to securing a channel 12 feet in depth. The depth of water in the channel at the present stage of water in Lake Michigan is 12 feet; at ordinary low water it is only 10 feet. The original depth was 4 feet or less; sometimes it was entirely closed.

It is now intended to increase the depth of the channel to 15 feet or more by extending the piers and dredging.

There has been expended upon this harbor up to June 30, 1886, $215,591.37.

During the fiscal year ending June 30, 1886, no work was done upon this harbor.

The funds now available, and the money asked for the fiscal year ending June 30, 1888, are to be applied to the replacing of the superstructure over 415 linear feet of the south pier, to pier extension, and to dredging.

The pier extension is not urgent, but to maintain the present piers and depth of channel an annual appropriation of $8,000 is necessary.

July 1, 1885, amount available	$1,836 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	473 87
July 1, 1886, amount available	1,362 20
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	6,362 20
Amount (estimated) required for completion of existing project	41,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 4.)

5. *Waukegan Harbor, Illinois.*—The present project was adopted in 1880, and, as since modified, consists in excavating a small basin in the low ground between the lake and bluffs to form the harbor, and in dredging an entrance between parallel piers from the lake to this basin. The harbor here is to be created upon a shallow exposed coast and

will not begin to be available for commercial purposes until the piers are sufficiently extended into the lake to allow the entrance to be dredged with hope of permanency and the basin excavated.

There has been expended upon this harbor up to June 30, 1886, $68,857.81.

During the year ending June 30, 1886, the north pier has been extended into the lake 32 feet.

The balance now available and the money asked for the fiscal year ending June 30, 1888, is needed to complete the pier-work at the entrance to the basin, and for dredging in the basin and entrance. The work is very much exposed, and it is advisable for the sake of economy to proceed rapidly with it. The advance of the fore-shore and the filling in with drifting sand is rapid. The cost will be materially increased by delay, and the work already done, being of wood, will deteriorate without benefit therefrom if not made available by sufficient progress.

The estimated cost of the work still to be done, excluding present balance, is $71,000.

July 1, 1885, amount available	$5,754 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,611 97
July 1, 1886, amount available	1,142 19
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	21,142 19
Amount (estimated) required for completion of existing project	71,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 5.)

6. *Fox and Wisconsin rivers, Wisconsin.*—The works for the improvement of the Fox and Wisconsin rivers were purchased by the United States from the Green Bay and Mississippi Canal Company in 1872. These works were all, except one stone lock, temporary structures, many of them in bad condition. There was no low-water navigation on the Upper Fox, and on the Lower Fox navigation was uncertain.

For the Fox River.—The adopted project contemplated the replacing of the temporary structures with permanent works, the construction of five additional stone locks on the Upper Fox, and widening and deepening the channels throughout the river and canals to 6 feet depth and 100 feet width.

For the Wisconsin River.—The method adopted has been to contract the channel-way by wing-dams of brush and stone, to give increased depth by concentrating the water and by scour due to the increased currents. The estimate, including the Wisconsin River, made in 1874 and 1876, was $3,745,663, since which time there has been appropriated $1,780,000, leaving for completion of the adopted project $1,965,663.

The general subject of the improvement of the Fox and Wisconsin rivers has been referred to the Board of Engineers, who have not yet announced any final conclusions. The necessary additional observations are now being taken for the Board.

Pending the final determination of the question of the practicability of improving the Wisconsin River, the original project is now held in abeyance, and the work confined to the Fox River under the modified project of the Board of Engineers, submitted September 17, 1884, approved by the Secretary of War December 10, 1884, as further modified by authority of the Chief of Engineers May 14, 1886.

This modified project applies only to the Fox River and its needs, and contemplates the renovation of 11 old locks, rebuilding the Cedars Lock of stone now on hand, and the deepening and widening the channel of the Fox River from Montello to Green Bay to 6 feet depth and 100 feet width; the estimate for which is $602,000.

The amount expended on the improvement of the Fox and Wisconsin rivers from 1867 to date is $2,587,642.07, and for operating and care of canals and other works of navigation applied to Fox and Wisconsin rivers up to fiscal year ending June 30, 1886, $89,309.40.

The result of this expenditure has been:

(1) *On the Fox River.*—The construction of 13 new locks of stone, 12 dams, 4 of which are temporary, 12 cut-offs, 10 miles of canals dredged and deepened, stone cut for 1 additional lock, and for sluice-ways and abutments of 1 dam. Over 2,000,000 cubic yards of material have been dredged from the Upper Fox, and all temporary structures repaired and maintained in working order. The navigation has thus been continuous throughout the season from Portage to Green Bay, there being 3 feet navigation on the Upper Fox and 5½ feet on the Lower Fox, except at the entrance to Lake Winnebago, where there is only 4½ feet.

There remains to be built under the original project 12 locks, 8 dams, 5 guard-locks, weirs or sluices in all dams not provided with them, deepening navigation to 6 feet throughout and widening the channels to 100 feet, erecting lock-tenders' dwellings, and strengthening and paving canal banks.

Under the modified project there remains to be done 2,800,000 cubic yards of dredging and rock excavation, the deepening of the De Pere Lock to 6 feet, the rebuilding Cedars Lock of stone, and the building of a new dam at Appleton. The old works to be maintained under the continuous appropriation.

(2) *On the Wisconsin River.*—To date 108,312 linear feet of wing-dams have been constructed over a distance of 50 miles, of which a section 12 miles in length below Portage has been completed. The result has been an increased depth of navigation wherever the works have been applied. There is not now, nor has there been, any regular navigation on the Wisconsin River, due to the prevalence and shifting nature of the sand-bars, and the consequent lack of any defined channel for considerable distances.

The practicability of improving the open river navigation of the Wisconsin by wing-dams to the extent required for an effective through route of navigation is to be determined by the results of the observations now in progress on the improved section of the river. As yet the river has not attained a low-water stage since observations have been carried on.

During the past year the following work has been done:

(1) *Wisconsin River.*—The work was restricted to the repair and maintenance of the wing-dams on the improved section below Portage, and to observations for discharge and depth at low water.

(2) *Fox River.*—On the *Upper Fox* the Governor Bend and Montello locks were renovated, and navigation maintained by timely repairs and by dredging bars.

On the *Lower Fox* the various mechanical works were maintained by timely repairs in serviceable condition, and the navigable depth of the channels and canals preserved by dredging. A site was purchased for Menasha Dam, for carrying out the provisos attached to the river and harbor acts of August 2, 1882, and July 5, 1884—items, Fox and Wisconsin rivers, and the construction of the dam begun, the dam partly completed and made available as a weir. Deepening the Menasha channel by rock excavation, and widening the Neenah outlet to Lake Winnebago, as recommended in the report of the Board of Engineers, September 17, 1884, approved by the Secretary of War, December 10, 1884, were begun and are under way at the close of the fiscal year.

The new work of improvement on the Fox and Wisconsin rivers during the last fiscal year was under the acts of August 2, 1882, and July 5, 1884. The works of maintenance were paid for under section 4 of the river and harbor act of July 5, 1884, which provides for the operating and care of canals and other works of navigation.

For the fiscal year ending June 30, 1887, it is proposed to apply the funds now available to continuing the work at Menasha and Neenah, to carry out the provisos attached to the river and harbor acts of August 2, 1882, and July 5, 1884—*i. e.*, to the completion of the lengthening of the Menasha Dam and widening the Neenah outlet; to deepening the Menasha outlet to Lake Winnebago to 6 feet by rock excavation, and to deepening and widening the Menasha Canal.

The funds asked for the fiscal year ending June 30, 1888, are for the furtherance of the modified project relating to the improvement of the Fox River below Montello, to be applied to deepening the De Pere Lock, to rebuilding the Cedars Lock of stone, to rock excavation on the Lower Fox, and to dredging in the Upper Fox.

July 1, 1885, amount available	$175,675 38
Fuel sold to officers, deposited to credit of appropriation	105 00
	175,780 38
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	107,079 22
July 1, 1886, amount available	68,701 16
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	124,951 16

Amount (estimated) required for completion of existing project	1,965,663 00
Amount (estimated) required for modified project, Fox River	546,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	200,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Under the continuous appropriation for operating and care of canals and other works of navigation, it is proposed to maintain existing navigation by timely repairs to old locks until replaced by new, and to continue the repairs of works that have already been completed and used, injured by the extraordinary flood of 1881:

Amount appropriated by act approved July 5, 1884	Indefinite.
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$42,622 00
Amount (estimated) for expenditures in fiscal year ending June 30, 1887	43,668 00

(See Appendix G G 6.)

IMPROVEMENT OF THE HARBORS OF CHICAGO AND CALUMET, ILLINOIS—IMPROVEMENT OF ILLINOIS AND CALUMET RIVERS—SURVEYS FOR HENNEPIN CANAL.

Officer in charge, Maj. W. H. H. Benyaurd, Corps of Engineers.

1. *Chicago Harbor, Illinois.*—The project of improvement now in course of execution at this harbor was adopted in 1870 and modified in

1878. The objects sought are, first, the formation of an outer harbor adjoining the entrance to the Chicago River, and designed also to furnish increased commercial facilities by relieving the river from its overcrowded condition; second, the creation of a harbor of refuge, affording a good anchorage in deep water, and safe access to the harbor and river.

The amount expended upon the work for harbor at Chicago since 1870 is $1,337,005.37, and has resulted in the completion of the outer harbor (excepting the dredging necessary to afford the contemplated depth of 16 feet); the completion of 3,836 feet of the exterior breakwater, with the exception of the superstructure on the easterly end thereof; and the building of four additional cribs yet to be sunk in position. No work was done during the fiscal year ending June 30, 1886, except that necessary for the care and preservation of public property, and the receiving of material contracted for, as the funds available would not admit of active operations.

On the 4th of December last a severe storm damaged 400 feet of the southerly breakwater of the outer harbor, necessitating repairing at the earliest possible moment, in order that the remainder of the structure shall be secured against further damage. As the cost of the necessary repairs will be in addition to the amount required to complete the improvement under existing project, the officer in charge has submitted an increased estimate amounting to $31,000 for that work and for other requirements in order to secure the stability of the structures.

With the funds available for the present fiscal year it is proposed to continue the extension of the exterior breakwater and to repair the break in the southerly breakwater caused by the storm of December 4.

To continue the work of improvement under the existing project the sum of $240,000 will be required.

July 1, 1885, amount available	$4,423 38
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,848 41
July 1, 1886, amount available	574 97
Amount appropriated by act approved August 5, 1886	75,000 00
Amount available for fiscal year ending June 30, 1887	75,574 97
Amount (estimated) required for completion of existing project	240,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	240,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 1.)

2. *Calumet Harbor, Illinois.*—The present project for the improvement of this harbor has for its object the creation and maintenance of a channel 300 feet wide and 16 feet deep from Lake Michigan to Calumet River.

The amount expended in the execution of this project to June 30, 1886, is $381,619.53; 5,360 feet of pier-work have been completed, and 384,376 cubic yards of material have been dredged from the channel.

No work was done during the past season, as the funds available were barely sufficient for the care and preservation of the public property.

The funds now available will be applied to the extension of the south pier.

The appropriation of $11,400 asked for is to be applied to the same work, and to the repair and preservation of the existing works.

July 1, 1885, amount available	$1,225 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	845 12
July 1, 1886, amount available	380 47
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,380 47

Amount (estimated) required for completion of existing project	11,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	11,400 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 2.)

3. *Illinois River, Illinois.*—Previous to the adoption of the present project the improvement of the Illinois River, as carried on by the General Government, consisted chiefly in constructing wing-dams and dikes and in dredging through the worst bars.

The amount expended in that way up to June 30, 1880, was $550,450.55.

The State of Illinois has constructed two locks, each 75 feet wide by 350 long between gates, situated at Henry, and Copperas creek.

The present project contemplates the extension of this slackwater system 100 miles below by the construction of two more locks and dams, situated, respectively, at La Grange and Kampsville. It is also proposed to dredge the channel of the river where needed from the State lock at Copperas Creek to the mouth of the river.

At Kampsville the foundation of the lock was completed two years ago, but the appropriations not being sufficiently large to carry on operations at both lock-sites, the coffer-dam and works were flooded, and have so remained.

At La Grange the lock-walls have been completed. The funds now available will be expended in constructing the lock-gates and purchasing material for the damage at La Grange, and in contracting for stone for the Kampsville lock. In addition, the amount allotted for dredging at Peoria will be expended for that purpose.

The amount required for the fiscal year ending June 30, 1888, will be expended in completing the work at La Grange and in carrying on operations at Kampsville.

July 1, 1885, amount available	$18,592 74
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	14,232 31
July 1, 1886, amount available	4,360 43
Amount appropriated by act approved August 5, 1886	112,500 00
Amount available for fiscal year ending June 30, 1887	116,860 43

Amount (estimated) required for completion of existing project	587,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	350,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1866.	

(See Appendix H H 3.)

4. *Calumet River, Illinois.*—The project for the improvement of the lower section of this river, extending from the harbor to the forks, a distance of 6½ miles, was recommended by a Board of Engineer Officers in accordance with the requirements of the river and harbor act of August 2, 1882. It was proposed to dredge a channel 200 feet wide and 16 feet deep, "no work, however, to be undertaken until the right of way shall have been conveyed to the United States free from expense, and the

United States released from all liability for damages to adjacent property-owners."

By the provisions of the river and harbor act of August 5, 1886, the improvement of the upper section of the river as far as Hammond is also contemplated and appropriation made therefor. It is intended to extend the project for the improvement of the lower river to cover this stretch also.

The work of improvement will be commenced so soon as the necessary releases have been obtained and approved by the Secretary of War. Parties interested in the improvement are actively engaged in securing the right of way required, and as the act last above referred to contains provisions for condemnation proceedings in the name of the United States in cases where it was impossible to obtain the land otherwise, it is believed that the entire right of way will be obtained during the present season.

As the improvement of the lower and upper sections of the river is now embraced under one head, the estimates therefor have been combined.

For continuing operations the sum of $100,000 is asked.

July 1, 1885, amount available	$50,000 00
July 1, 1886, amount available	50,000 00
Amount appropriated by act approved August 5, 1886	30,000 00
Amount available for fiscal year ending June 30, 1887	80,000 00
Amount (estimated) required for completion of existing project	345,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 4.)

5. *Surveys for the Hennepin Canal.*—Additional surveys for a route from the summit level to the Mississippi River were made in the fall of 1885, and reported upon by Maj. Thomas H. Handbury, Corps of Engineers, and printed in House Ex. Doc. No. 117, Forty-ninth Congress, first session.

July 1, 1885, amount available	$8,271 51
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	7,637 85
July 1, 1886, amount available	633 66

(See Appendix H H 5.)

IMPROVEMENT OF HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN AND OF GRAND RIVER BELOW GRAND RAPIDS.

Officer in charge, Capt. D. W. Lockwood, Corps of Engineers, with Capt. C. F. Palfrey, Corps of Engineers, under his immediate orders.

1. *Charlevoix Harbor, Michigan.*—The average width of the original channel of entrance was 75 feet; the depth varied from 2 to 6 feet. The present project for its improvement, adopted in 1868 and revised in 1875 and 1876, is to dredge a channel 100 to 150 feet wide to a depth of 12 feet, and to protect both sides with close piling. This was modified in 1876 by substituting crib-work for pile-piers.

The amount expended to June 30, 1885, was $66,207.10, and resulted in obtaining a channel of navigable width and 12½ feet mid-depth between the piers, and a 12-foot channel 80 feet wide connecting Round and Pine lakes, revetted on the north side for 339 feet and on the south side 366 feet. The amount expended during the fiscal year ending June 30, 1886, was $3,774.79, and resulted in repairing and refilling 330 feet of old north pier from shore-line out.

The available depth for navigation is about 12 feet.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to extending the south pier into Lake Michigan in accordance with approved project, completing the revetment of channel between Round and Pine lakes, and in general repairs to piers and plank beam revetments.

July 1, 1785, amount available	$4,802 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,774 79
July 1, 1886, amount available	1,028 11
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for the fiscal year ending June 30, 1887	11,028 11
Amount (estimated) required for completion of existing project	105,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 1.)

2. *Frankford Harbor, Michigan.*—The natural channel of entrance to this harbor was not more than from 3 to 4 feet deep. The present project for its improvement, adopted in 1866, was to dredge an outlet through a strip of land separating Lake Aux Becs Scies from Lake Michigan, and to build two parallel piers 200 feet apart, extending from 12 feet soundings in the inner lake to the same depth in Lake Michigan. The amount expended to June 30, 1885, was $238,283.98, and resulted in securing a channel of entrance 195 feet wide, with an available depth of 12 feet.

The amount expended during the fiscal year ending June 30, 1886, was $588.74, in paying office and other expenses, the balance being too small for any work but that of minor repairs.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is for pier-extension, in accordance with approved project, and for general repairs.

July 1, 1885, amount available	$4,654 37
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	588 74
July 1, 1886, amount available	4,065 63
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	11,565 63
Amount (estimated) required for completion of existing project	68,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 2.)

3. *Harbor of Refuge at Portage Lake, Michigan.*—No natural channel existed prior to the beginning of the improvement. The project for improvement, adopted in 1879, was to make this a harbor of refuge, with a navigable channel 300 feet wide and not less than 18 feet deep. The piers as constructed, however, are 370 feet apart.

The amount expended to June 30, 1885, was $58,491.08, and resulted in revetting the north side of the channel and the extension of the revetment by pier-work into Lake Michigan a distance of 525 feet beyond the shore-line; also, in building 573 feet of revetment and pier on the south side, and opening a cut 50 feet wide and 12 feet deep between the lakes.

The amount expended during the fiscal year ending June 30, 1886, was $8,326.70, and resulted in building 805 feet of revetment on south side of channel and in removing 19,110 cubic yards of material from between the piers to keep a channel open. The present depth of water is about 11 to 12 feet.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to pier extension and dredging, in accordance with the approved project.

July 1, 1885, amount available		$9,008 92
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$7,508 70	
July 1, 1886, outstanding liabilities	818 00	
		8,326 70
July 1, 1886, amount available		682 22
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		15,682 22

Amount (estimated) required for completion of existing project	182,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	60,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 3.)

4. *Manistee Harbor, Michigan.*—A narrow channel, not more than 8 feet, was obtained at this harbor by the slab-pier built by local enterprise. The present project for its improvement, adopted in 1866 and modified in 1870 and 1874, was to afford a channel of entrance of navigable width not less than 12 feet deep. The amount expended to June 30, 1885, was $216,259.87, and resulted in securing a depth of 15 feet between the piers and 13 feet on the bar outside. The amount expended during the fiscal year ending June 30, 1886, was $6,522.81, and resulted in placing one crib 50 feet long by 30 feet wide on pile foundation in extension of north pier. The depth of water available for vessels up to Manistee Lake is about 12 feet, although between the piers the depth is somewhat greater. The amount that can be profitably expended during the fiscal year ending June 30, 1888, it is proposed to apply to pier-extension, in accordance with approved project, and to general repairs of piers and revetments.

July 1, 1885, amount available	$11,740 13
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,522 81
July 1, 1886, amount available	5,217 32
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	15,217 32

Amount (estimated) required for completion of existing project	92,700 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 4.)

5. *Ludington Harbor, Michigan.*—The channel made by local enterprise at this harbor was narrow and not more than 7 feet deep. The project for its improvement, adopted in 1867, was to afford a channel of entrance to Pere Marquette Lake, of navigable width, and not less than 12 feet deep.

The present project, approved January, 1885, is to widen the entrance to 400 feet by building a new south pier 400 feet south of the present north pier, remove the present south pier, and dredge the channel to a depth of 18 feet.

The amount expended to June 30, 1885, was $229,298.38, and resulted in securing a channel about 200 feet wide and 14 feet deep. The amount expended during the fiscal year ending June 30, 1886, was $5,190.99, and resulted in placing superstructure on crib sunk in previous year, and in removing 9,990 cubic yards of material from channel. The depth of water available is about 14 feet. The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to building new south pier and dredging in accordance with the approved project.

July 1, 1885, amount available	$6,886 62
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	5,190 99
July 1, 1886, amount available	1,695 63
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	57,945 63
Amount (estimated) required for completion of existing project	362,935 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	120,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 5.)

6. *Pentwater Harbor, Michigan.*—The original channel of entrance was narrow, and not more than 4 feet in its shoalest part. The present project for its improvement, adopted in 1866, was to afford a channel of navigable width and not less than 12 feet deep.

The amount expended to June 30, 1885, was $203,474.32, and resulted in securing a channel of navigable width and about 12 feet deep. The amount expended during the fiscal year ending June 30, 1886, was $1,405.52, and resulted in placing superstructure on crib sunk in previous year, rebuilding superstructure on a part of north pier, leveling up, repairing, and refilling pier-head of south pier, and in refilling piers where necessary to stop leaks. The depth of water is about 12 feet between the piers.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to extending the south pier in accordance with approved project, and to general repairs.

July 1, 1885, amount available	$4,345 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,405 52
July 1, 1886, amount available	2,940 16
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	12,940 16
Amount (estimated) required for completion of existing project	45,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 6.)

7. *White River Harbor, Michigan.*—The old channel was narrow, crooked, and too shoal to accommodate any but very small vessels. The present project for its improvement, adopted in 1866, was to afford a channel of navigable width not less than 12 feet deep. The amount expended to June 30, 1885, was $231,176.58 and resulted in obtaining a channel of navigable width and 11 feet deep.

The amount expended during the fiscal year ending June 30, 1886, was $4,503.44, and resulted in rebuilding and refilling pile-pier, head of north pier, and in cutting down old pile-work preparatory to putting on new superstructure. The depth of water is between 9 and 10 feet.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to pier extension in accordance with approved project, and to rebuilding superstructure on pile-piers and revetments.

July 1, 1885, amount available		$6,373 42
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,016 39	
July 1, 1886, outstanding liabilities	487 05	
		4,503 44
July 1, 1886, amount available		1,869 98
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		11,869 98
Amount (estimated) required for completion of existing project		84,225 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 7.)

8. *Muskegon Harbor, Michigan.*—The original channel was irregularly defined by slab-piers which gave fair access, but a bar just at the end of the piers, on which there was only 7 feet of water, obstructed navigation. The present project for improvement, adopted in 1866, was to obtain a channel of entrance of navigable width, and to extend the piers over the bar to 17 feet soundings. Modified in 1880 so as to secure 300 feet width of entrance. The amount expended to June 30, 1885, was $203,940.86, and resulted in obtaining a width of entrance of 300 feet, the main channel inside being 186 feet. The depth of water at close of fiscal year was about 15 feet.

The amount expended during fiscal year ending June 30, 1886, was $11,262.47, and resulted in extending the north pier 100 feet by two cribs on pile foundation, and in general repairs to piers. The depth of water remains about the same as last year.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to pier extension under approved project and to general repairs.

July 1, 1885, amount available	$17,559 14
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,262 47
July 1, 1886, amount available	6,296 67
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	18,796 67
Amount (estimated) required for completion of existing project	101,125 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 8.)

9. *Grand Haven Harbor, Michigan.*—The natural outlet was wide but shoal, the water being only 9 feet deep in the best course. The present project for its improvement, adopted in 1866, was to obtain a channel of navigable width with a minimum depth of 18 feet. The amount expended to June 30, 1885, was $452,605.83, and resulted in obtaining a channel of entrance 400 feet wide and 18 feet deep.

The amount expended during the fiscal year ending June 30, 1886, was $28,038.59, and resulted in extending the south pier 200 feet by four cribs 30 feet wide on pile foundation, and in repairing piers and revetments where necessary. The depth of water remains the same as last year.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to pier extension under the approved project and to making general repairs.

July 1, 1885, amount available		$41,760 32
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$27,670 80	
July 1, 1886, outstanding liabilities	367 79	
		28,038 59
July 1, 1886, amount available		13,721 73
Amount appropriated by act approved August 5, 1886		30,000 00
Amount available for fiscal year ending June 30, 1887		43,721 73
Amount (estimated) required for completion of existing project		180,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		60,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 9.)

10. *Grand River, Michigan.*—The portions of channel below Grand Rapids to be improved have less than 4 feet depth of water at low stage. The original project adopted in 1881 is to give relief to light navigation by securing 4 feet depth of water at low-water stage. The project now in force is to secure a 4-foot navigable depth by dredging to 4.5 feet.

The amount expended to June 30, 1885, was $30,795.78, and resulted in dredging a portion of the channel above Lake Shore Railway Bridge, making a detailed survey of the river from the head of navigation to a point 11¼ miles down-stream, and in dredging under new project 14,112 cubic yards of material from the channel, the depth of cut being 4.5.

The amount expended during the fiscal year ending June 30, 1886, was $17,494.33, and resulted in removing 61,883.51 cubic yards from the channel and carrying the improvement down-stream a distance of 7.6 miles.

No appropriation is asked for.

July 1, 1885, amount available		$19,204 22
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$13,057 52	
July 1, 1886, outstanding liabilities	4,436 81	
		17,494 33
July 1, 1886, amount available		1,709 89

(See Appendix I I 10.)

11. *Black Lake Harbor, Michigan.*—The channel made by the Harbor Board of the city of Holland was narrow, irregular, and only 5½ feet deep. The project for its improvement, adopted in 1866 and modified in 1873, was to obtain a channel of entrance of navigable width and not less than 12 feet deep. The amount expended to June 30, 1885, was $250,614.24, and resulted in obtaining a channel of about 200 feet width

t the entrance, somewhat narrower inside, with a depth of about 11 eet.

The amount expended during the fiscal year ending June 30, 1886, as $1,766.07, and resulted in placing 33 cords of stone in north pier, n leveling and rebuilding outer end of south pier, and refilling it with tone, and in cutting down and rebuilding a part of south revetment. he depth of water remains about the same as last year.

The amount that can be profitably expended during the fiscal year nding June 30, 1888, is to be applied towards completing the harbor nder the approved project.

uly 1, 1885, amount available	$4,001 07
uly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,766 07
uly 1, 1886, amount available	2,235 00
mount appropriated by act approved August 5, 1886	5,000 00
mount available for fiscal year ending June 30, 1887	7,235 00
Amount (estimated) required for completion of existing project	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 11.)

12. *Saugatuck Harbor, Michigan.*—The channel originally made by local nterprise was narrow and not more than 7 feet deep in the best water. he project for its improvement, adopted in 1869, was to obtain a channel of entrance of navigable width, with a minimum depth of 10 feet.

The amount expended to June 30, 1885, was $123,683.94, and resulted n obtaining a narrow channel about 8 feet deep inside, and 11 feet on he bar.

The amount expended during the fiscal year ending June 30, 1886, was 399.84, for office expenses and contingencies. The depth remains bout the same as last year.

The amount that can be expended during the fiscal year ending June 0, 1888, is to be applied to securing the south pier and "maintaining he existing condition of the improvement."

uly 1, 1885, amount available	$3,755 06
uly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	399 84
uly 1, 1886, amount available	3,355 22
mount appropriated by act approved August 5, 1886	8,000 00
mount available for fiscal year ending June 30, 1887	11,355 22

(See Appendix I I 12.)

13. *South Haven Harbor, Michigan.*—The channel was originally made y private enterprise, was narrow, and not more than 7 feet deep in the eepest place. The present project for its improvement, adopted in 6, and modified in 1879, was to obtain a channel of entrance of navigable width, not less than 14 feet deep.

The amount expended to June 30, 1885, was $168,285.86, and resulted obtaining a channel of navigable width, and 9.5 feet deep between e piers, 10.5 feet up to the railway bridge, and 14 feet on the bar. e amount expended during the fiscal year ending June 30, 1886, was ,165.53, and resulted in removing 29,865 cubic yards of material from tween the piers. The depth of water is now 12 feet between the ers. The depth on the bar and in the river to the railway dock rein the same as last year.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to pier extension and dredging in accordance with approved project, and to making general repairs.

July 1, 1885, amount available	$8,714 14
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,165 53
July 1, 1886, amount available	5,548 61
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	10,548 61
Amount (estimated) required for completion of existing project	77,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 13.)

14. *Saint Joseph Harbor, Michigan.*—The natural channel was about 250 feet wide and 12 feet deep at the entrance, shoaling to 9 feet in the river above. The present project for its improvement, adopted in 1866 and 1874, was to obtain a channel of entrance of navigable width and not less than 16 feet deep. The amount expended to June 30, 1885, was $311,745.80, and resulted in securing a channel of entrance of about 14 feet depth, and a canal leading from Saint Joseph Harbor to Benton Harbor 100 feet wide and 11 feet deep, partially revetted.

The amount expended during the fiscal year ending June 30, 1886, was $5,728.34, and was expended in closing two breaks in north pier near the shore-line, caused by severe storms, and in building a scow 70 feet by 30 feet by 6½ feet.

The amount that can be profitably expended during fiscal year ending June 30, 1888, is to be applied to rebuilding the north pier, resuperstructuring the south pier, and constructing close-piling wing-dam from end of north pier to railway bridge, in accordance with approved project.

July 1, 1885, amount available		$20,367 20
July 1, 1886, amount expended during fiscal year, including transfer to Michigan City for timber purchased, exclusive of liabilities outstanding July 1, 1885	$5,680 57	
July 1, 1886, outstanding liabilities	47 77	
		5,728 34
July 1, 1886, amount available		14,638 86
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		24,638 86
Amount (estimated) required for completion of existing project		41,015 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 14.)

15. *Michigan City Harbor, Indiana—Outer Harbor.*—Work at this harbor was commenced by the Government in 1836. The first project was that of 1857, for the construction of a breakwater. Various modifications up to 1870 provided for pier extensions and dredging of channel. In 1870 a project for an exterior harbor was approved. In 1882 a project for an exterior breakwater west of the harbor entrance and the construction of a pier at west end of exterior breakwater of outer harbor was adopted. The amount expended to July 30, 1885, was $800,699.84, and resulted in completing the breakwater for outer harbor and extending the breakwater pier 300 feet. The depth of water was sufficient to admit the largest class of vessels on the lakes. The amount

expended during the fiscal year ending June 30, 1886, was $8,581.04, and resulted in placing one crib on pile foundation, in extension of breakwater pier, and putting superstructure on 150 feet of same; the superstructure on 408 feet of west pier near shore-line was rebuilt, and the substructure of 500 feet more leveled up to receive superstructure. Other repairs were made where necessary, and the plant put in working condition. The depth of water remains the same as last year.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to the construction of the west exterior breakwater, the completion of the breakwater pier at entrance, and renewal of superstructure and filling of old west pier.

July 1, 1885, amount available		$13,718 75
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$8,111 04	
July 1, 1886, outstanding liabilities	470 00	
		8,581 04
July 1, 1886, amount available		5,137 71
Amount appropriated by act approved August 5, 1886		54,375 00
Amount available for fiscal year ending June 30, 1887		59,512 71
Amount (estimated) required for completion of existing project		395,625 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		150,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 15.)

Inner Harbor.—The site of the present inner harbor was originally a small creek, crooked and with a depth insufficient for commercial purposes. The first project was that of 1870 for dredging up to the railroad bridge. In 1878 a project, submitted by the officer in charge, for extending the inner harbor up Trail Creek by dredging, was adopted, the cut to be 120 feet wide and 15 feet deep, and the city to revet the cut.

The amount expended to June 30, 1885, was $88,965.31, and resulted in securing a depth of 17 feet up to the railroad bridge, and about 15 feet beyond that point. The amount expended during the fiscal year ending June 30, 1886, was $4,224.36, and resulted in removing 22,365 cubic yards of material in Trail Creek, giving a depth of 17 feet up to a point 600 feet south of Sixth Street Bridge; the depth above to within 00 feet of upper basin is 13 feet; also in removal of 4,804 cubic yards of material in channel near shore-line.

The amount that can be profitably expended during the fiscal year ending June 30, 1888, is to be applied to continuation of dredging according to approved project.

July 1, 1885, amount available		$6,034 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,029 36	
July 1, 1886, outstanding liabilities	195 00	
		4,224 36
July 1, 1886, amount available		1,810 33
Transferred from Saint Joseph appropriation (timber for scow)		488 84
Amount appropriated by act approved August 5, 1886		1,875 00
Amount available for fiscal year ending June 30, 1887		4,174 17
Amount (estimated) required for completion of existing project		3,125 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		3,125 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 15.)

IMPROVEMENT OF SAINT MARY'S RIVER—ENLARGEMENT OF AND OPERATING SAINT MARY'S FALLS CANAL—CONSTRUCTION OF HARBOR OF REFUGE ON LAKE HURON, AND IMPROVEMENT OF CERTAIN HARBORS ON LAKE HURON AND OF SAGINAW RIVER—PRESERVATION OF AND OPERATING SAINT CLAIR FLATS CANAL—IMPROVEMENT OF DETROIT RIVER.

Officer in charge, Lieut. Col. O. M. Poe, Corps of Engineers, with Lieut. H. F. Hodges, Corps of Engineers, under his immediate orders.

1. *Hay Lake Channel, Saint Mary's River, Michigan.*—The original estimates for this improvement were based upon a project for a channel 300 feet wide and 7 feet deep, leaving the present navigable channel of Saint Mary's River at Sugar Island Rapids (about 2¼ miles below the canal); through these into Hay Lake, and then, by way of the Middle Neebish, rejoining the present navigable channel at the foot of Sugar Island, thus saving a distance of 11 miles and obtaining a route which it is practicable to mark with lights so as to be navigable at night, a condition impracticable with the present channel.

The estimated cost of this project was $2,127,292. It was subsequently modified to increase the depth to 19 feet, and it is now evident that a further modification is required with a view to obtaining a depth of 20 feet.

These modifications will necessarily increase the cost, but not to so great an extent as would at first be supposed, because the prices at which the most difficult part of the work can be done prove to be lower than those of the original estimates.

Based upon the best data available, the estimated cost of the improvement, if modified as proposed, is $2,659,115.

The amount thus far appropriated for the work is $325,000, and the expenditures to June 30, 1886, including all determined outstanding liabilities, amount to $291,218.50, which has been principally applied to excavation under a contract at Middle Neebish, to surveys, to engineering, and office expenses, &c. The available balance is to be applied, as far as may be, to excavation at Middle Neebish.

The amount of material removed from the proposed channel to June 30, 1886, was 352,128 cubic yards, of which 344,124 cubic yards were removed from Middle Neebish.

Owing to the distance over which the plant can be distributed, a large amount of work can be carried on at the same time, and the sum that can be profitably expended during the fiscal year ending June 30, 1888, is therefore correspondingly large, and an appropriation of $400,000 is recommended for continuing the excavation at Middle Neebish, and beginning operations at Sugar Island Rapids, and on the flats at the lower end of Hay Lake.

July 1, 1885, amount available		$124,207 57
Received from sale of fuel		16 13
		124,223 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$76,328 11	
July 1, 1886, outstanding liabilities	14,017 32	
		90,345 43
July 1, 1886, amount available		33,878 27
Amount appropriated by act approved August 5, 1886		150,000 00
Amount available for fiscal year ending June 30, 1887		183,878 27

Amount (estimated) required for completion of existing project	$2,184,115 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	400,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix J J 1.)

2. *Saint Mary's Falls Canal and River, Michigan.*—This improvement, originally projected to obtain a 16-foot navigation between Lakes Superior and Huron, has been completed accordingly, at a cost, to June 30, 1886, of $2,405,432.83.

Statistics show that the commerce using this route is increasing so rapidly that if it continues at the same rate for four years the present lockage system at the canal will not suffice to pass all the vessels.

The greatest depth advisable to obtain in the canal and river is 20 feet in the clear, because that can be effected at reasonable cost, and any additional depth is not likely to be required for a long time to come, because a channel of greater depth can be obtained across Lake Saint Clair only at such enormous cost as to render its expediency very doubtful.

A necessary part of the plan of enlargement is the increase in the capacity of Saint Mary's Falls Canal, including its lockage system.

It is now proposed to give the canal a depth of 20 feet, and to replace the present "Old Locks" (of 1855), as useless under the changed condition, by a lock 800 feet between gates, 100 feet wide, having 21 feet of water on its miter-sills, and a lift of 18 feet.

The estimated cost of these improvements is $2,055,576, and an appropriation of $400,000 is earnestly recommended for the next fiscal year to continue the work.

July 1, 1885, amount available	$182 31
July 1, 1886, outstanding liabilities	182 31
Amount appropriated by act approved August 5, 1886	250,000 00

Amount (estimated) required for completion of project	1,805,576 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	400,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix J J 2.)

3. *Operating and care of Saint Mary's Falls Canal, Michigan.*—During the fiscal year the canal was open to navigation two hundred and twenty-two days. It closed December 2, 1885, and was opened April 25, 1886. Six thousand two hundred and three vessels and rafts, having a registered tonnage of 3,529,184 tons and carrying 3,701,014 tons of freight, 34,356 passengers, passed through in 3,232 lockages.

The staple articles transported were 922,158 tons of coal; 32,615 tons of copper; 1,696,263 barrels of flour; 17,346,212 bushels of grain; 1,529,021 tons of iron ore; 73,691 tons of pig and manufactured iron; 136,664,000 feet of timber, board measure; 159,840 barrels of salt; 3,434 tons of silver ore; 9,366 tons of building stone; and 199,052 tons of unclassified freight.

The estimated expense of operating and care for the fiscal year was	$32,000 00
The actual expenses were	25,400 95
The receipts for rents and dry-dockage were	498 00

The estimated amount required on account of operating and care of the canal for the fiscal year ending June 30, 1887, is $36,540, all of which is already provided for by indefinite appropriation.

July 1, 1885, amount available		$32,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$23,349 00	
July 1, 1886, outstanding liabilities	2,051 95	
		25,400 95
Amount available by allotment for fiscal year ending June 30, 1887		36,540 00

(See Appendix J J 3.)

4. *Dry-dock at Saint Mary's Falls Canal.*—In the printed Annual Report of the Chief of Engineers for the fiscal years ending June 30, 1884 and 1885 (see pages 2030 *et seq.* of 1884 and 2124 *et seq.* and 2188 *et seq.* of 1885), are to be found full reports upon this subject.

Under the provisions of the act of the legislature of the State of Michigan, in accordance with which the Saint Mary's Falls Canal was transferred to and received by the General Government, it seems to be obligatory upon the United States to construct a dry-dock at Sault Ste. Marie.

For reasons fully set forth in the reports referred to, the officer in local charge strongly objects to the construction of a dry-dock in immediate proximity to the locks, and suggests that it be located at the eastern end of the area transferred from the Fort Brady military reservation to the canal reservation.

The estimated cost of a dry-dock so located is $323,872, and the amount which can be profitably expended during the fiscal year ending June 30, 1888, is $215,000, of which $150,000 should be appropriated by the United States and $65,000 (more or less) transferred by the State of Michigan.

(See Appendix J J 4.)

5. *Harbor at Cheboygan, Michigan.*—The project for the improvement of this harbor was adopted in 1871, the object being to afford a channel of entrance from the Straits of Mackinac 200 feet wide and not less than 14 feet in depth into Cheboygan River.

This project was modified in August, 1882, to provide for the deepening of the basin opposite the steamboat landing and the entire channel to the 15-foot curve in the Straits of Mackinac.

Nothing was done towards the improvement during the fiscal year, and upon the 30th of June, 1886, its condition was substantially as reported at the close of the preceding year.

The same opinion is still entertained in regard to the amount required to complete the improvement, and therefore the estimate of 1885 is repeated, and the sum of $100,000 is named as that which will probably be required for that purpose, the ultimate cost thus amounting to but little more than half the original estimate.

The original estimate for this work was		$395,000 00
Amount thus far appropriated	$118,000 00	
Received from sale of fuel	3 00	
Revised estimate of cost of completion	100,000 00	
Total		218,003 00
Difference		176,997 00

The foregoing estimate, indicating that the object may probably be attained at so much less cost than the amount of the original estimate, is based upon the possibility that the long pier provided for and intended to protect the channel may be omitted. Should this not prove to be the case, the original estimate will be found not to have been too great.

The reasons for undertaking this improvement have been so frequently stated in preceding annual reports that it is deemed unnecessary to repeat them, and an appropriation of $20,000 is recommended with which to continue the work during the fiscal year ending June 30, 1888.

July 1, 1885, amount available	$5,000 00
Received from sale of fuel	13 13
	5,013 13
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	22 47
July 1, 1886, amount available	4,990 66
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	19,990 66
Amount (estimated) required for completion of existing project	85,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 5.)

6. *Harbor at Thunder Bay, Michigan.*—The project for the improvement of this harbor was adopted in 1876, the object being to obtain an entrance channel from the bay into the river of navigable width and of not less than 13 feet in depth. The project was subsequently modified with a view to obtaining a depth of 14 feet. This had been practically accomplished at the date of the Annual Report for 1884.

It was then stated that the improvement is of such a character that it will require attention from time to time, and as the nature of this could not be foretold, it was recommended that a sufficient appropriation be made to render available the sum of $10,000.

During the last fiscal year no complaints concerning this harbor have been received, owing, probably, to the high stage of water in Lake Huron, and only $23.02 was expended on account of the harbor. Consequently it is not necessary to do more than repeat the recommendation of the last two years, which would require an appropriation of $5,474.93.

The commerce directly benefited by this work is that to and from Thunder Bay River, at the mouth of which is situated the important and rapidly growing city of Alpena.

July, 1885, amount available	$4,534 96
Received from sale of fuel	13 13
	4,548 09
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	23 02
July 1, 1886, amount available	4,525 07
Amount (estimated) required for maintenance of existing project	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 6.)

7. *Harbor at Au Sable, Michigan.*—The present project for the improvement of the harbor was adopted in 1866, and modified in 1879, the object being to obtain a channel of not less than 10 feet in depth for a width of 100 feet from the lake to the State road bridge at Au Sable.

The attempts to improve this harbor have not been so successful as had been hoped. The reasons for this are fully set forth in the Annual

Report of 1885 (see pages 2130, *et seq.*, Annual Report of the Chief of Engineers for 1885).

Since submitting that report, the officer in charge of the work has seen no reason for modifying the opinion therein expressed, that it is not possible to make any permanent improvement of the harbor at a cost at all commensurate with the advantages to be gained.

The officer in charge of the work does not recommend the abandonment of the improvement, but refrains from recommending at this time any appropriation for the fiscal year ending June 30, 1888.

About 130,000,000 feet, board measure, lumber, 45,000,000 lath, and a quantity of salt, are annually shipped from this port.

July 1, 1885, amount available	$4,900 55
Received from sale of fuel	13 13
	4,913 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	52 15
July 1, 1886, amount available	4,861 53

(See Appendix J J 7.)

8. *Saginaw River, Michigan.*—The present project aims to secure a channel of 200 feet in width, 14 feet in depth from Saginaw Bay to Bay City, and 12 feet in depth thence to the head of navigation in Saginaw River.

After the close of the fiscal year 1884–'85, operations were continued on the bar at the mouth of the river, under contract dated October 2, 1884.

This contract expired by its own limitation August 31, 1885, the funds available for the purpose being practically exhausted at the same time.

The result accomplished during the fiscal year 1885–'86 was the removal of 16,200 cubic yards of material.

It is estimated that the original project can be completed for the sum of $337,250, which sum is obtained by deducting from the estimate of 1883–'84 the amount since appropriated.

The interests involved are so large as to justify the most extensive operations, and the length of the channel (nearly 23 miles) is such that they can be readily carried on without interfering with each other.

It is therefore recommended that the sum stated below be appropriated for the fiscal year ending June 30, 1888.

July 1, 1885, amount available	$8,509 12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,461 39
July 1, 1886, amount available	47 73
Amount appropriated by act approved August 5, 1886	33,750 00
Amount available for fiscal year ending June 30, 1887	33,797 73
Amount (estimated) required for completion of existing project	337,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 8.)

9. *Harbor of Refuge, Sand Beach, Lake Huron, Michigan.*—The present project for this improvement was adopted in 1873. It consists of a breakwater constructed of timber cribs filled with stone, inclosing an area which is to be deepened, where necessary, by dredging.

Its object is to afford a harbor of refuge to the vessels engaged in the navigation of the northern and northwestern lakes, when caught by heavy weather near the dangerous Pointe aux Barques. Previous to 1876 vessels so caught were compelled to run a distance of 60 miles, and find refuge in Saint Clair River. After the subsidence of the gale, those upward bound had to work their way back again.

The estimate of the probable cost of the improvement was $1,442,500, and the aggregate amount of appropriations (previous to that of August 5, 1886) has been $975,000. The total amount expended to June 30, 1886, was $970,930.16.

The total amount of available funds has thus been $975,213.76, or $467,286.24 less than the amount of the original estimate, whilst the estimated cost of the work remaining to be done to complete the project is only $100,000 (less $30,000 appropriated by act of August 5, 1886)—that is to say, the total cost of the project will be but three-fourths of the estimate.

On the 4th and 5th December, 1885, a northeast storm of unprecedented severity wrought serious damage to the work, the extent being given in detail in the report.

The estimated cost of repairing the damage is $60,000.

The timber superstructure is now at that stage of its life when extensive renewals in some more durable materials should be undertaken. It is proposed to use concrete for this purpose, and an estimate of $50,000 is submitted for beginning this work.

The river and harbor act of August 5, 1886, appropriates $45,000 for repairs, and the total amount of funds required for the purpose indicated is $165,000 additional, which the officer in charge earnestly recommends be appropriated.

July 1, 1885, amount available		$24,521 55
Received from sale of fuel		13 13
		24,534 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$18,613 41	
July 1, 1886, outstanding liabilities	1,637 67	
		20,251 08
July 1, 1886, amount available		4,283 60
Amount appropriated by act approved August 5, 1886		75,000 00
Amount available for fiscal year ending June 30, 1887		79,283 60
Amount (estimated) required for completion of existing project		70,000 00
Amount that can be profitably expended for repairs, &c., in fiscal year ending June 30, 1888		135,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J J 9.)

10. *Steam launch or tug for Harbor of Refuge, Lake Huron, Michigan.*—Under the provisions of the act approved June 19, 1882, a contract has been made for the purchase of a steam launch for use at the harbor of refuge, Lake Huron, building by David Bell, of Buffalo, N. Y., under specifications. The boat is expected to be first class in every respect, and to be specially adapted to the requirements of the service required of her.

The expenditures on this account to the close of the fiscal year amounted to $338.94.

No additional appropriation is required.

July 1, 1885, amount available	$10,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	338 94
July 1, 1886, amount available	9,661 06

(See Appendix J J 10.)

11. *Ice-harbor of Refuge at Belle River, Michigan.*—The project for this improvement was adopted in 1880, the object being to obtain a channel 50 feet wide, 13 feet deep to the first bridge, 12 feet deep thence to the second bridge, and affording a safe harbor against running ice.

The work has been completed according to the project and gives satisfaction.

Nothing further is required at this time, and in consequence no estimate is submitted.

July 1, 1885, amount available	$47 10
July 1, 1886, amount available	47 10

(See Appendix J J 11.)

12. *General repairs and renewals at Saint Clair Flats Ship-Canal.*—The canal was projected in 1866 with a view to obtaining a straight channel 13 feet deep and 300 feet wide, across Saint Clair Flats, the channel being bounded on each side by a dike 7,221 feet long, or an aggregate of 14,442 feet.

These dikes consist of timber cribs, resting upon piles driven into the original bottom of the shoal, the crib pockets being filled with material dredged from the channel.

To maintain a channel bank a single row of sheet-piling was driven along the channel face of the cribs previous to dredging.

The lake sides of the dikes were protected from wave action by shorter sheet-piling.

In 1873 the demands of commerce required a deeper channel, and this was obtained by dredging to 16 feet, for a width of 100 feet on each side of the axis of the canal, or a width of 200 feet in all.

The single row of sheet-piling is insufficient to prevent the leakage of material through it into the channel, and it should be re-enforced with a double row of at least 8 feet greater penetration, with a view not only to the protection of the present channel, but to further dredging at an early day to obtain a greater depth.

As the dikes now stand, intended for a 13-foot channel, and made to do duty for one of 16 feet, it is manifest that no greater depth can be maintained without such re-enforcement.

The entire timber structure is much decayed and should be removed as soon as possible.

In the Annual Report of the Chief of Engineers for 1885 (see pages 2159 *et seq.*) a project was submitted for such works as will accomplish the desired result and at the same time provide for subsequently deepening the channel to 20 feet.

The estimated cost of the project was $153,289, and it is again respectfully submitted, with the remark that the estimate relates only to the dikes, and does not include any portion of such excavation as must subsequently be made.

The bad condition of the entire superstructure and sheet-piling of the dikes, dwelt upon in prior reports, has become worse through the natural processes of decay, and proceed more rapidly as the timber grows less able to resist them.

The great importance of this improvement is so well known, its use is so advantageous to a commerce hailing from every lake port, both in the United States and Canada, and which is nearly, if not quite, equal to our entire foreign commerce by sea, that no additional representation seems to be necessary to secure early and favorable consideration.

The necessity for the work proposed is immediate and urgent.

Amount appropriated by act approved August 5, 1886	$18,750 00
Amount (estimated) required for completion of existing project	135,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	67,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 12.)

13. *Operating and care of Saint Clair Flats Canal, Michigan.*—The minor repairs involved in operating and care of the canal during the fiscal year amounted to only $232.57. This was due, as in the preceding year, to the fact that the stage of water was such that but few vessels grounded in the canal, and slight damage was done to the dikes.

Cavities in the dikes were filled with cedar bark; the willows growing on the dikes were trimmed, and the cuttings tied in bundles, also deposited in cavities; plank were placed on the lake side of the dikes, where they are most threatened with injury from the wash of waves.

At the beginning of the fiscal year a contract for dredging was in force. The work was completed on the 19th of September, 1885. The entire amount of dredging done under contract was 64,580 cubic yards, of which 60,298 cubic yards were dredged during the fiscal year and 4,282 cubic yards during June, 1885. The price paid was 11½ cents per cubic yard, a remarkably low rate.

Of the total amount dredged and removed, 7,546 cubic yards were from the head of the canal, and 57,034 from the foot.

The estimated cost of operating and care of the canal (including the dredging) for the fiscal year was $17,700.

The actual cost was $10,171.54, of which an itemized statement is hereto appended (Appendix J J 13) as required by law.

The estimated cost of operating and care of the canal for the fiscal year ending June 30, 1887, is as follows:

Salary of custodian	$1,500
Current repairs	3,500
Total	5,000

July 1, 1885, amount available	17,700 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,588 35
Amount available by allotment for fiscal year ending June 30, 1887	5,000 00

(See Appendix J J 13.)

14. *Clinton River, Michigan.*—In 1870 the channel over the bar at the entrance to the river afforded a depth of only 3½ feet, whilst the depth in the river some distance above the bar was 10 feet.

The present project for improvement was adopted in 1870 and modified in 1880. It aims to obtain an entrance channel of 8 feet.

In a report dated January 23, 1885, the officer in local charge proposed a further modification of the project, and submitted estimates of the probable cost, amounting to $32,926.

The conditions have not changed meanwhile.

Amount appropriated by act approved August 5, 1886	$6,000 00
Amount (estimated) required for completion of existing project	26,926 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 14.

15. *Detroit River, Michigan.*—Before improvement to the channel at Lime Kiln Crossing, Detroit River, was undertaken, not more than 13 feet of water could be depended upon, the ordinary depth being much affected by the direction and force of the winds.

As originally projected in 1874, the improvement was to consist of a curved channel 300 feet wide, with a uniform depth of 20 feet, and the estimate was based upon this project.

In 1883 the project was modified to secure a straight channel, the least width of which should be 300 feet, with a somewhat greater width at each end, utilizing the work already done, and this constitutes the project now under execution, which, if the present rate of progress is maintained, will be completed before the close of the current season.

The obstruction is a ledge of solid rock, which is first broken up by drilling and blasting, and the débris then removed by dredging.

The unavoidable result of this is to leave channel banks with rugged edges, which would prove destructive to any vessels striking them, and in order to diminish the danger of such results it is now earnestly recommended by the officer in charge that the width of the channel be increased to 400 feet by removing 100 feet additional from the western (American) side.

To do this will require the excavation of 25,765 cubic yards of rock, at an estimated cost of $168,000.

This recommendation is made with the greater confidence because the ultimate cost of the improvement will even then be but little more than half the original estimate. That is to say, the estimated cost of the improvement, as modified in 1883, was $1,206,500, whilst the actual cost of the same will not exceed $535,000, and, with the estimated cost of the additional width ($168,000), the amount will be $703,000.

July 1, 1885, amount available		$149,385 46
Received from sale of fuel		48 39
		149,433 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$68,060 59	
July 1, 1886, outstanding liabilities	22,027 96	
		90,088 55
July 1, 1886, amount available		59,345 30
Amount appropriated by act approved August 5, 1886		37,500 00
Amount available for fiscal year ending June 30, 1887		96,845 30
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		130,500 00

(See Appendix J J 15.)

IMPROVEMENT OF HARBORS ON LAKE ERIE WEST OF BUFFALO, WITH THE EXCEPTION OF THE HARBOR AT ERIE—IMPROVEMENT OF SANDUSKY RIVER.

Officer in charge, Maj. L. Cooper Overman, Corps of Engineers.

1. *Monroe Harbor, Michigan.*—The original project for the improvement of this harbor was adopted in 1835, when Monroe was a town of considerable importance, and when the navigable waters of the River Raisin were separated from the waters of Lake Erie by extensive shoals.

It provided for cutting a canal between the river and the lake, 4,000 feet long and 100 feet wide, through the peninsula called "River Raisin Point," and protecting the entrance into the lake by parallel piers running out to a depth of 10 feet, the object being to afford a channel of entrance of navigable width with a depth of 10 feet. Work was commenced in 1835 and has been continued from time to time since that date.

At the close of the last fiscal year there was a good channel, with a least depth of 10 feet, up to a point below Monroe, which is deemed sufficient for the present commerce of the port.

During the fiscal year ending June 30, 1886, no work of any kind was done for want of funds.

The total amount appropriated for this harbor has been $213,515.27, which has resulted in securing a navigable channel with a least depth of 10 feet up to a point just below the docks at Monroe, where rock bottom occurs.

If this harbor is to be kept up, there is need of extensive repairs to piers and canal revetment, in order to prevent their unlimited destruction or more expensive renewals in later years. These repairs are estimated to cost $20,000.

The present commerce of Monroe is not sufficient, in the opinion of the officer in charge, to justify such a large expenditure. Hence, he considered a small annual appropriation for repairs sufficient until an increase of commerce demands the extensive renewals. But as there has been no appropriation for Monroe Harbor since 1882, and then only $1,000, the proposed annual repairs have not been made, and extensive repairs are badly needed.

The river and harbor act of August 5, 1886, appropriates $2,000. It will be expended in repairs.

Amount appropriated by act approved August 5, 1886	$2,000 00
Amount (estimated) required for completion of existing project	18,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	2,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 1.)

2. *Toledo Harbor, Ohio.*—When operations were commenced at this harbor, in 1866, the channel through the bay was narrow and intricate, presenting a depth of only 11 feet. The original project provided for cutting a channel 200 feet wide and 12 feet deep through Maumee Bay, and this was amended from time to time, until the present project provides for a channel 200 feet wide at bottom and 16 feet deep at low water between the city of Toledo and deep water in Lake Erie. In 1868, there was a channel 100 feet wide and 12 feet deep; in 1875, the depth had been increased to 14 feet, and at the beginning of the fiscal year ending June 30, 1886, there was a good channel 200 feet wide at bottom on the ranges and from 260 to 350 feet wide at the angles, with a depth of from 15 to 17 feet at low water between Toledo and deep water in the lake.

The total amount appropriated for this harbor since 1866 to close of fiscal year ending June 30, 1886, has been $704,700, all of which sum has been expended. This expenditure has resulted in obtaining a good 16-foot channel where before there was a narrow, intricate channel with but 11 feet for vessels.

During the fiscal year the sum of $253.81 has been expended in maintaining the channel.

The estimated cost of the present project was $570,000, of which amount there has been appropriated $510,000. The balance of $60,000 yet required will not complete the project as originally estimated, owing to the time consumed in doing the work for want of adequate appropriation, the contingent expenses, and the annual removal of the deposits of each winter and spring, repeated for twelve years, having absorbed at least $100,000 of the original estimate. It will therefore require at least $160,000 to complete the improvement of the natural channel, the whole of which can be expended during the year ending June 30, 1888, in deepening and widening the channel between Toledo and 16 feet of water in Lake Erie, after which an annual expenditure of about $20,000 will be needed to maintain the dredged channel through the open bay.

The act of July 5, 1884, appropriated $25,000 to commence the work of making a straight channel for the Maumee River from its mouth to Lake Erie, in accordance with the second plan recommended by Major Wilson in report dated November 19, 1881. This plan is estimated to cost $2,363,923, which amount includes item for contingent expenses amounting to $214,902.

The officer in charge believes that the sum of $500,000 is as small a sum as should be on hand to begin this work in a proper manner in accordance with the specified plan.

In accordance with the above views it was recommended by him that the appropriation of $25,000 be retained until further appropriations made the amount large enough to properly commence the work. This was approved and no operations were undertaken during the fiscal year ending June 30, 1885, in connection with the "Straight Channel" improvement, or for over a year after the passage of the act.

During the summer of 1885, there being no work in progress for the improvement of Toledo Harbor, and but little Government work being done at any of the Lake Erie harbors for want of appropriations, a vigorous effort was made by citizens of Toledo to have work on the "Straight Channel" improvement begun by the expenditure of the $25,000. This effort was successful and the expenditure ordered. The engineer in charge was instructed under date of August 15, 1885, to take the necessary steps to begin the work by dredging along a "section of channel between the point where the present channel trends towards the east and the land at North Cape Point," the said section not to connect with the existing channel nor extend so far north as to come under the influence of Ottawa River, which crosses the line of proposed channel.

Proposals for the dredging were invited and contract entered into dated September 21, 1885, for the removal of 130,000 cubic yards, more or less, of material from along a section of channel as indicated, at the rate of 10 cents per cubic yard, place measurement.

The contract was completed and closed November 30, 1885, and under it 127,260 cubic yards of material were dredged and removed at a cost of $12,726. It resulted in making a cut in the open bay of about 7,500 feet in length, about 100 feet in width, with 11 feet depth of water. No practical benefit accrued from making the cut.

No further work was done for the "Straight Channel" improvement during the remainder of the fiscal year.

The total expenditures during the fiscal year were $15,367.39 and a partial refilling has occurred in the cut during the winter of 1885-86 and spring of 1886.

The act approved August 5, 1886, making appropriations for rivers and harbors reads, as relates to Toledo Harbor, Ohio, as follows:

> Improving harbor at Toledo, Ohio: Continuing improvement of the Maumee River, by a straight channel along such line as may be approved by the Secretary of War, $112,500; and the balance of $25,000 heretofore appropriated are hereby made available for clearing the old channel.

The proviso as to the line of "the Straight Channel" will necessitate additional examination of the locality in order to determine which is the best line for it. The necessary examination can be made this fall, contracts perfected, and work begun vigorously in the spring of 1887.

Natural channel.

July 1, 1885, amount available	$253 81
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	253 81
Amount appropriated by act approved August 5, 1886	9,632 61

Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Making a straight channel to Lake Erie.

July 1, 1885, amount available	$25,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	15,367 39
July 1, 1886, amount available (this balance made applicable to old channel by act of August 5, 1886)	9,632 61
Amount appropriated by act approved August 5, 1886	112,500 00

Amount (estimated) required for completion of existing project	2,226,423 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	250,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 2.)

3. *Port Clinton Harbor, Ohio.*—The first survey of the harbor was made in 1867, but no action was taken upon it. In 1870 a new survey was made, which showed the channel at the entrance to be narrow and intricate, with a depth of only 5 feet. The original project provided for cutting a channel 8 feet deep through the outer bar and constructing piers from the shore out to the necessary depth.

Efforts were made, without success, during the years 1872, 1873, and 1874 to obtain a channel by dredging only, but the required depth could not be maintained.

The present project, adopted in 1875, provides for a pile revetment running from the north shore of the Portage River, opposite the town, 867 feet out into the lake, in a direction north 57° east; then inclining towards the north, a pile-pier about 1,500 feet long extends to the depth of 10 feet in the lake; parallel to this and 200 feet from it an east pier 2,600 feet long, to run out from the south shore of the river. It is expected that a full depth of 9 feet can be maintained by confining the waters of the Portage River between these piers.

The total amount appropriated for this harbor to the close of the fiscal year ending June 30, 1886, has been $46,000, all of which has been expended. The expenditure has resulted in obtaining a depth of 9 feet from the lake to the town where there was originally but 5 feet.

During the fiscal year no work of any kind has been done, for want of funds, making two years without any work.

The original estimate for the work was $122,000, a revised estimate $90,000, of which $46,000 has been appropriated, but the engineer in charge questions the advisability at present of expending the remaining $44,000, as the commerce, present or prospective, is not such as to justify such an expenditure.

If it is deemed best to continue the improvement as projected, the sum of $20,000 can be expended during the fiscal year ending June 30, 1888, extending the piers and repairing same. The river and harbor act of August 5, 1886, appropriated $2,000 for this harbor, to be used in "repairs of existing works." It will be expended during the fiscal year.

July 1, 1885, amount available	$17 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	17 70
Amount appropriated by act approved August 5, 1886	2,000 00
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	41,000 00

(See Appendix K K 3.)

4. *Sandusky City Harbor, Ohio.*—The original survey of this harbor was in 1826, but no appropriation was made until 1844. In the latter year the depth in the channel through the outer bar was 10 feet and the greatest depth in the bay was about 12 feet. There was an extensive breach in the peninsula which protects the harbor on the west and northwest. The original project provided for closing this breach by crib-work and deepening the channel through the outer bar to 12 feet.

The appropriations of 1844 and 1852 were applied to closing the breach in the peninsula, but the failure of further appropriations left the work unfinished, and in 1864, when operations were resumed, the old work was found to have been destroyed.

In 1864 a project was proposed for opening a channel 400 feet wide and 12 feet deep through the outer bar. This has been amended from time to time, and at present the project calls for a channel through the outer bar and the bay up to within 50 feet of the line of docks and then parallel to the docks, the portion through the bar and bay to be 200 feet wide and that parallel to the docks 100 feet wide, the whole to be 15 feet deep. In 1869 the channel through the outer bar was 240 feet wide and 12 feet deep. In 1872 the depth was increased to 13 feet and work was commenced upon the channel within the bay. In 1875 there was a channel 100 feet wide through the outer bar and one 150 feet wide and from 13 to 15 feet deep within the bay, up to a point about 1½ miles from the docks at Sandusky City.

At the close of the fiscal year ending June 30, 1885, the sum of $254,450.07 had been expended on this harbor, and there was a channel through the outer bar about 150 feet wide, with a depth of about 15 feet, and a depth of 15½ feet for a width of 50 feet, and through the bay up to a point 50 feet from line of docks, with a width of 200 feet and a depth of about 15 feet.

During the fiscal year ending June 30, 1886, the sum of $398.22 has been expended; 741 cubic yards of mud, clay, sand, &c., have been removed from the channel through outer bar, and it was thereby restored to a similar condition as at the close of 1885. An annual removal of at least 10,000 cubic yards is necessary to maintain the unfinished channel, after which the additional dredging can be applied toward the completion of the channel to 200 feet in width and 15 feet in depth.

The sum of $10,000 is required to complete the existing project, the whole of which can be profitably expended during the period ending June 30, 1888, in widening and deepening the channel from deep water in the lake to the docks at Sandusky City.

An increased depth of 16 feet at low water has been recommended for this harbor on account of the increased size of vessels navigating the lakes.

The estimated cost of this extra depth is $61,000 additional, and if this project is favorably considered the sum of $30,000 additional (making $40,000 in all) can be profitably expended during the fiscal year ending June 30, 1888.

The act of July 5, 1884, contained the following proviso in connection with the appropriation of $20,000 for this harbor: "One-half of said sum to be expended in deepening the channel, and the other half in the repair of existing works."

Since 1855 there has been no work carried on by the United States for the improvement of Sandusky Harbor other than dredge work. Previous to and during 1855 a number of rough cribs had been located along the then existing sand-bar or peninsula, which protected Sandusky Bay on the north and west from the winds and lake waves, but during the winter of 1859 the crib-work was nearly all destroyed, and no expenditure has since been made towards replacing it. At present there is not a vestige of cribs to be seen.

There are therefore no "existing works" in the improvements of the harbor of Sandusky City, and only one-half of the whole appropriation was therefore deemed applicable to continuing the work on the existing channel, and no work was possible with the $10,000 held as "unavailable."

The river and harbor act of August 5, 1886, made this sum of $10,000 available, and made an additional appropriation of $5,000 (making a total of $15,000 to be expended during the fiscal year ending June 30, 1887, in dredging in accordance with the existing project).

July 1, 1885, amount available	$629 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	398 22
July 1, 1886, amount available	231 71
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,231 71

(See Appendix K K 4.)

5. *Sandusky River, Ohio.*—During the years 1867 and 1872 the sum of $30,000 was expended in opening a navigable channel with a depth of 8 feet from Sandusky Bay to Fremont, a distance of 17 miles; since 1872 the cuts then made through the various bars have filled up.

The present project, which was based on a survey made August, 1880, provides for opening a channel 100 feet wide and 9 feet deep between the town of Fremont and the depth of 9 feet in Sandusky Bay, at an estimated cost of $44,000.

At the close of the fiscal year ending June 30, 1883, the sum of $21,500 had been appropriated for the project of 1880, of which amount $20,871.53 has been expended, and by the expenditure there was at the close of the season of 1883 a good channel, with least depth of 9 feet, from Fremont, the head of navigation, to the lake. The last appropriation for this river was that of August 2, 1882.

The balance on hand, viz, $628.47, was too small to attempt any further work last season, but will be held for an emergency or until further appropriations are made.

Up to the present date $51,500 has been appropriated for this river, of which $50,871.53 has been expended. The sum of $22,500 will be required to complete the existing project, the advisability of which is deemed doubtful by the officer in charge.

July 1, 1885, amount available	$628 47
July 1, 1886, amount available	628 47
Amount (estimated) required for completion of existing project	22,500 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix K K 5.)

6. *Huron Harbor, Ohio.*—The present plan for the improvement of this harbor consists of parallel piers, 140 feet apart, running out into the lake. It was adopted in 1826, and modified in 1871, the object being to afford a channel of entrance of navigable width, and of not less than 14 feet in depth.

When work was commenced, in 1827, there was a bar at the mouth of the river, dry at low water. In 1839 the channel was 130 feet wide, and not less than 9½ feet deep; in 1844 this depth was found to have been maintained, but in 1852, as very little work had been done for fourteen years, for want of appropriation, the piers were in a dilapidated condition, and the channel had shoaled. In 1866 there was a depth of 11 feet at the entrance. At the close of the fiscal year ending June 30, 1885, there was a good channel through the outer bar, with a depth of 15 feet, and between the piers, with a depth of from 16 to 17 feet. The superstructure of both piers, except where repaired in 1883 and 1884, was in a decayed condition and needed immediate renewal.

The heavy gales of the springs of 1884, 1885, and 1886 did considerable damage to the piers and to the beaches, so that a breach was made between inner end of east pier and shore. Extensive and immediate repairs are much needed.

Up to the end of the fiscal year the sum of $114,273.71 has been appropriated for this harbor, of which amount $114,064.78 has been expended, including the last appropriation, that of July 5, 1884.

A good wide channel with least depth of 14 feet has been obtained where originally there was a sand-bar, dry at low water.

The estimated cost of renewing the superstructure of the piers is $22,000; $13,500 has been appropriated, but owing to the extra repairs made necessary by the storms of 1884, 1885, and 1886, the estimate to complete the renewals is made greater.

The river and harbor act of August 5, 1886, appropriated $3,000 for this harbor. It will be expended this season in repairing piers, etc.

July 1, 1885, amount available	$213 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4 08
July 1, 1886, amount available	208 99
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,208 99
Amount (estimated) required for completion of existing project	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix K K 6.)

7. *Vermillion Harbor, Ohio.*—The original project for this improvement in 1826, when the mouth of Vermillion River was closed by a sand-bar, upon which there was a depth of less than 2 feet, consisted of parallel piers running out to a depth of 12 feet in the lake, from each side of the mouth of the river, in order to secure a depth of 10 feet. This

project has been amended from time to time, and now provides for a depth of 14 feet.

In 1838 there was a channel 50 feet wide and 6 feet deep. No appropriations were made between 1838 and 1866, and in the latter year the piers were found to be dilapidated and the depth at the entrance to be 7 feet.

In 1878 the channel was about 70 feet wide, with a depth of about 12 feet.

At the close of the fiscal year ending June 30, 1885, the piers were in fair condition; the depth in channel was about the same as at the close of the previous fiscal year. The amount appropriated to close of fiscal year ending June 30, 1886, has been $114,942.32, of which sum $114,183.64 has been expended.

The act of July 5, 1884, made no appropriation of funds for this harbor; hence but a limited amount of repairs could be done with the small balance of funds on hand.

No work was done during the fiscal year ending June 30, 1886.

The amount estimated for the completion of the proposed project can be expended during the period ending June 30, 1888, in removing rock, shoal, sand, &c., from the channel and repairing the piers, but the Engineer in charge is doubtful as to the advisability of such an expenditure.

The river and harbor act of August 5, 1886, appropriated $3,000 for this harbor, which will be expended this season in repairs, &c.

July 1, 1885, amount available	$908 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	150 00
July 1, 1886, amount available	758 68
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,758 68
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	11,000 00

(See Appendix K K 7.)

8. *Mouth of Black River, Ohio.*—The present project for the improvement of this harbor consists of parallel piers, 200 feet apart, running out to a depth of 16 feet in the lake. It was adopted in 1828, modified so as to give an increased depth in 1873, and again in 1880, the object being to afford a channel of entrance of navigable width and not less than 16 feet in depth.

When work was commenced in 1828 there was a depth of only 3 feet at the entrance; in 1839 there was a least depth of 9½ feet. But one appropriation of $5,000 was made between 1839 and 1865, and in the latter year the piers were found to be in a dilapidated condition; but a narrow channel, with a least depth of 7 feet, remained near the west pier. In 1871 there was a depth of 12 feet; in 1874, of 14 feet; and at the close of the last fiscal year there was a good wide channel, with a least depth of 16½ feet from the lake up into the river.

Up to the close of the fiscal year ending June 30, 1885, there had been appropriated the sum of $200,138.73, of which $200,138.73 had been expended, with which a channel with least depth of 16½ feet has been obtained where originally there was but 3 feet at the entrance.

At the close of the fiscal year ending June 30, 1885, both piers were in fair repair, but nothing was accomplished towards extension of piers, which is the most important work when funds sufficient shall be available. In April, 1886, it was reported that a shoal had formed in channel beyond piers; but being without funds no action could be had towards its removal.

The unexpected and extra repairs made and to be made at this harbor, will increase the estimate for repairs and renewal and prolonging piers at least $12,000, so that the sum of $20,000 is still needed to complete the existing project.

The river and harbor act of August 5, 1886, appropriated $10,000 for this harbor, all of which will be expended during the fiscal year ending June 30, 1887, in accordance with existing project and in repairs.

July 1, 1885, amount available	$0 35
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	35
Amount appropriated by act approved August 5, 1886	10,000 00
Amount (estimated) required for completion of existing project	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 8.)

9. *Rocky River, Ohio.*—The project for the improvement of this river was adopted in 1871, the object being to afford a channel of entrance 100 feet wide and from 6 to 12 feet deep. It required the construction of a pier 500 feet long, and a large amount of excavation.

The pier as projected was constructed, but only a small amount of excavation was done, and no further appropriations were made for continuing the work after March 3, 1875.

By the act of June 14, 1880, an appropriation of $4,000 was made for repairs, and during the years 1880 and 1881 portions of this amount were expended in placing the pier in good condition. The storms of 1883 did considerable damage to this pier, and it was repaired during the fiscal year ending June 30, 1884, at a cost of $1,248.61. At the close of that season the pier was in fair condition, but the storms of the springs of 1884, 1885, and 1886 have again damaged the pier, and considerable repairs are now needed. As the act of July 5, 1884, made no appropriation for this harbor, and the balance on hand is too small to attempt any repairs, there will be no work practicable until further appropriation, and the damaged pier will be still further improved. The sum of $3,000 is required for immediate repairs, if deemed advisable.

July 1, 1885, amount available	$131 87
July 1, 1886, amount available	131 87

(See Appendix K K 9.)

10. *Cleveland Harbor, Ohio.*—The present project for the improvement of the mouth of the Cuyahoga River was adopted in 1825, and has been amended from time to time to gain increased depth. It consists of parallel piers about 200 feet apart, running out to a depth of 16 feet in the lake.

When operations were commenced in 1825 there was a long, low sand-bar, where the river now empties into Lake Erie, and the entrance was through a narrow, intricate channel with a depth of about 3 feet.

At the close of the fiscal year ending June 30, 1886, there had been expended about $368,000, and there was as the result a good wide channel at the entrance of the harbor with a depth of from 17 to 20 feet between the lake and the railroad bridge at the inner end of the piers, with a pile protection work 620 feet long at the inner end of the west pier, constructed in 1882.

The storms of the winter and spring of this year did some damage to piers, and their use by vessels to "lay up" to, and also destroyed many timbers, all of which had to be repaired during the fiscal year ending June 30, 1886, at a cost of about $1,000.

The new breakwater.—The original project for a harbor of refuge provides for an outer breakwater, starting from the lake shore about 700 feet west of the upper end of the old river-bed.

This breakwater runs out in a direction about due north, a distance of 3,130 feet, to a depth of 28 feet. The angle is then turned, and it runs for 4,030 feet nearly parallel to the shore with a spur 100 feet long on the north side of the lake-arm, and 200 feet from its eastern end, in a depth of from 28 to 30 feet. The entrance to the harbor on the east side it was proposed to protect by extending the east pier at the mouth of the river 1,400 feet.

To the close of the present fiscal year the sum of $809,206.26 has been expended, and 7,160 linear feet of breakwater had been finished, which completed lake-arm of the breakwater, leaving but the eastern protection to be built to complete the harbor of refuge.

The engineer in charge in May, 1884, suggested that the plan for the closing of the eastern side of the harbor of refuge be changed; that instead of prolonging the east pier another lake-arm of breakwater be built to the eastward, leaving an opening opposite the piers of 350 feet for an entrance. This plan would give about 80 per cent. additional harbor room, and would give as much protection to the original harbor as the present plan. The increased cost would be proportionately small, and the entire cost of the harbor of refuge thus enlarged would be about the amount of the revised estimate for completion upon the present plan, and nearly $500,000 less than the original estimate.

This project was referred to a Board of Engineers, which in September, 1884, approved of the project in an amended form. The recommendation of the Board having been finally approved, with slight modification, the matter was made the subject of a special communication to the House of Representatives in January, 1885. But owing to the failure of the river and harbor bill of 1885 no sanction was given by Congress for the application of the remainder of the $100,000 appropriated by act of July 5, 1884, towards the construction of the proposed eastern arm of the breakwater, and no work was practicable during the past fiscal year.

The remaining balance on hand July 1, 1885, when all outstanding contracts were completed, was $1,135.29, too small a sum, to invite proposals for continuing the breakwater; hence there has been no work done during the fiscal year ending June 30, 1886, for the extension of the breakwater, the appropriation of July 5, 1884, being unavailable for the proposed eastern extension of the breakwater, and no work will be practicable until further legislation, thereby occasioning over two and three-fourths years' delay in progress of the work.

The amount expended for repairs to piers and breakwater, incidental expenses, superintendence, &c., during the fiscal year was $14,133.43.

Total appropriated for the harbor of refuge to July 1, 1886, is $900,000, of which sum $809,206.28 has been expended (to same date), less about $34,000 expended in repairs to piers, dredging, &c., for Cleveland harbor proper.

The river and harbor act of August 5, 1886, reads as follows as relates to harbor at Cleveland, Ohio:

> Improving harbor at Cleveland, Ohio, on the last plan projected, $93,750, of which $30,000 are to be used in building a parapet on the existing breakwater, and the $100,000 now on hand to be available for work on the last plan.

The above funds will be expended during the fiscal year ending June 30, 1887, in building parapet on the west breakwater and in constructing about 1,200 linear feet of east breakwater on the approved plan.

July 1, 1885, amount available	$1,135 29
July 1, 1885, amount partly unavailable	100,000 00
	101,135 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	14,133 43
July 1, 1886, amount partly available	87,001 86
Amount appropriated by act approved August 5, 1886	93,750 00
Amount available for fiscal year ending June 30, 1887	180,751 86
Amount (estimated) required for completion of existing project	319,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix K K 10.)

11. *Fairport Harbor, mouth of Grand River, Ohio.*—The present project for the improvement of this harbor consists of parallel piers, 200 feet apart, running out into the lake. It was adopted in 1825, and has been modified by prolonging the piers from time to time so as to give increased depth, the object being to afford a channel of entrance of navigable width and not less than 16 feet in depth. When the work of improvement was commenced, in 1826, the mouth of the river was closed by a sand-bar 1,200 feet wide, at times so hard and dry that teams could be driven across.

In 1829 the depth in the channel was about 8 feet, and in 1839, when work was suspended, there was a depth of 11 feet, and any vessel then navigating the lakes could enter at any time without danger.

In 1865 the piers were found to be seriously dilapidated. In 1870 there was a depth of 12 feet in the channel. In 1879 this depth was increased to 14 feet, in 1881 to 15 feet, and at the close of the fiscal year ending June 30, 1886, there was a good channel between the piers with least depth of 16 feet at low water, and in the lake beyond piers with least depth of 15½ feet at ordinary level of the lake.

During the fiscal year the work in progress at beginning was completed by which the east pier was extended 80 feet, the superstructure of the west pier repaired, and minor repairs made to both piers. The dredging in spring of 1885 restored a good 16-foot channel between the piers and a good 15½-foot channel through the bars in lake beyond end of piers. The above work was under the appropriation of July 5, 1884.

The sum of $6,087.32 was expended during the fiscal year.

Extensive improvements as to docks and yards for receiving cargoes of iron ore and shipping coal have been commenced at Fairport Harbor by Pittsburgh capitalists. The gauge of the Painesville and Youngstown Railroad is being changed to standard gauge, and connections made in the interest of the Baltimore and Ohio Railroad Company. These changes will be completed during the summer of 1886, and it is expected they will largely increase the business of this harbor. The extension of piers and repairs should be made at as early a day as possible.

As the river and harbor act of August 5, 1886, appropriated $18,750 for this harbor, the work of improvement, in accordance with existing project, will be continued during the fiscal year ending June 30, 1887.

July 1, 1885, amount available	$6,087 32
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,087 32
Amount appropriated by act approved August 5, 1886	18,750 00

Amount (estimated) required for completion of existing project	31,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 11.)

12. *Ashtabula Harbor, Ohio.*—The original project for the improvement of this harbor was adopted in 1826. The rock bottom was then found at 9 feet below the surface, and there was a depth of only 2 feet of water on the bar at the entrance when operations were commenced.

The project provided piers running out on either side of the mouth of the river from shore to 12 feet water in the lake.

The present project contemplates the extension of the piers out to 16 feet water, the removal of the decayed portions of both piers and rebuilding with new material, at the same time straightening the line of the west pier so as to afford a uniform width of 160 feet in the channel.

Operations were commenced in 1826, and have been prosecuted with more or less interruption and suspensions (no work was done between 1839 and 1865), and have resulted in a much-improved harbor. At the close of the year 1885 there was a good wide channel 15½ to 16 feet deep from the lake into the harbor.

There has been appropriated a total of $372,401.21 up to the close of the fiscal year ending June 30, 1886, all of which has been expended.

During the fiscal year the balance of the old west pier was removed for 400 linear feet shoreward to widen and straighten the channel; about 380 linear feet of this shore thus exposed was partially revetted with timber revetment, all in accordance with existing project. There was a good channel between the piers with 16 feet depth of water, except where rock bottom occurs at less depth. The bar in lake at end of piers gave considerable trouble to vessels this spring. The piers should be extended at as early a day as possible, and dredging is needed immediately. The exhaustion of the appropriations left this harbor in bad condition, and the delay consequent thereon is both unfortunate and expensive, and unless some work is possible this season much work already begun will be swept away.

Revised estimates give the sum of $50,250 as required to complete the existing project, all of which amount can be profitably expended during fiscal year ending June 30, 1888, in renewing piers, extending piers, dredging, and rock excavation.

The river and harbor act of August 5, 1886, appropriated $30,000 for continuing the improvement of this harbor. It will be expended in rock excavation, dredging, and repairs to piers.

July 1, 1885, amount available	$13,962 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	13,962 40
Amount appropriated by act approved August 5, 1886	30,000 00

Amount (estimated) required for completion of existing project........	$50,000 0
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,250 0
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 12.)

13. *Conneaut Harbor, Ohio.*—The original project for the improvement of this harbor was adopted in 1829. Operations were carried o during the years 1830 to 1832, and from 1836 to 1838, inclusive, which consisted in the construction of piers 125 feet apart, running from shore out to a depth of 12 feet of water in the lake, and in dredging. Th design was to afford a depth of 12 feet of water through the bar at th mouth of Conneaut Creek, which bar was dry at low water, when wor was commenced.

The improvements have been prosecuted at this harbor with more o less interruptions and suspensions. No work was done from 1839 t 1844, from 1845 to 1852, from 1853 to 1866, and none for the past fo years. The best channel ever obtained was 11 feet, and the more usu depth has been 8 or 9 feet. The present depth of water on the bar i less than 7 feet. Up to the close of the present fiscal year the sum o $112,629.39 has been appropriated for this harbor, of which sum $112, 629.39 has been expended. The present project for this improvemen contemplates rebuilding the east pier and renewing the superstructu of the west pier, at an estimated cost of $35,090. The last appropria tion for this harbor was that of June 14, 1880, amounting to only $6,00

The commerce of the port has always been small.

July 1, 1885, amount available..	$6 1
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885..	6 1

Amount (estimated) required for completion of existing project........	35,090 0
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 13.)

14. *Dunkirk Harbor, New York.*—The existing project for theimprove ment of this harbor was adopted in 1870, the object being to form a artificial harbor by constructing a breakwater 2,860 feet long and near parallel with the shore, and by excavating a channel so as to afford depth of 13 feet into this harbor, the estimated cost of which wa $350,000.

The breakwater construction has been carried out in part, 1,341 fe having been completed at a cost of $98,000, and the channel has bee excavated to 13 feet in depth, but is quite narrow, besides presenti the ragged edges of the unblasted rock, jutting out on either side, an being exposed to wind and waves from any direction between nort west around to northeast. It is therefore somewhat dangerous at tim for a vessel to make the entrance. In case any further extension of th breakwater is deemed advisable the officer in charge recommends it extension to the westward 560 feet, as contemplated in the original de sign, which would diminish in some degree the dangers of the entranc and at the same time create additional shelter within the harbor. A to tal of $459,079.38 has been appropriated, of which amount $459,044.1 has been expended to the close of the fiscal year ending June 30, 18

The breakwater, if extended 560 feet to the westward, might also, wit benefit to the harbor, be extended 300 feet eastwardly, a total of 8 feet. It would then be 659 feet shorter than its original estimat length. The cost of such extensions, with present prices of materials, would be some $70 per linear foot, and would amount to $60,200.

During the fiscal year work was in progress for about nine weeks in dredging and repairs to east breakwater.

The condition of the harbor is about the same as at the close of the last fiscal year, as the destruction by storms and detonation counterbalanced the small improvements made.

The river and harbor act of August 5, 1886, appropriated $20,000 for this harbor, which amount will be expended during the fiscal year ending June 30, 1886, in accordance with the existing project.

July 1, 1885, amount available	$8,467 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,432 13
July 1, 1886, amount available	35 27
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	20,035 27
Amount (estimated) required for completion of existing project	40,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 14.)

15. *Removing sunken vessels obstructing or endangering navigation.*—The wreck of a schooner loaded with stone that had sunk in the channel between the piers at Fairport, Ohio, was, after due notice given to the owners to remove it, removed by contract at a cost of $989, and the wreck and cargo sold at auction. The proceeds of the sale, $55, were covered into the Treasury.

(See Appendix K K 15.)

IMPROVEMENT OF THE HARBORS OF ERIE, PENNSYLVANIA, AND BUFFALO, NEW YORK, AND OF NIAGARA RIVER.—IMPROVEMENT OF HARBORS ON LAKE ONTARIO.

Officer in charge, Capt. Edward Maguire, Corps of Engineers.

1. *Erie Harbor, Pennsylvania.*—The original survey of this harbor was made in 1819, at which time the channel was narrow and tortuous, with a depth of only 6 feet. In 1823 a plan for the improvement was adopted, and constitutes the present work at the entrance to the harbor, excepting some changes which have been required either on account of the age of the structures originally built or other causes.

The piers have been extended from time to time, and are now in good condition.

The present project contemplated the extension of the pier to the 16-foot curve in the lake, and the maintenance of a channel of navigable width and 16 feet in depth from the harbor inside to the lake outside.

The officer in charge is of the opinion that, on account of the rapid current which flows in and out through the channel, the north pier should not be extended, but that, owing to the increasing shoaling which has already taken place, the south pier should be extended 400 feet. He recommends that the neck of the peninsula be protected by a breakwater, and that the movement of sand around the eastern end of the peninsula, and which threatens to close the harbor entrance, be arrested by the construction of jetties perpendicular to the shore of the peninsula. The estimated cost of the work is $173,044.50.

If the present project of pier extension alone be carried out, the amount required will be $84,120.

Operations have been prosecuted with more or less interruptions and suspensions (no work was done from 1838 to 1842, from 1846 to 1853, and from 1855 to 1864), and have resulted in much benefit to the harbor and its channel entrance. The work during the fiscal year consisted of minor repairs to the piers.

To carry out the recommendation of the Board of Engineers of June 14, 1882, $10,000 of the amount available for the harbor are set aside to provide for the prompt construction of a dike at the neck of the peninsula in case of necessity.

The total amount appropriated for this harbor up to June 30, 1886, is $731,367.23, of which $673,202.75 have been expended.

July 1, 1885, amount available		$59,130 86
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$966 38	
July 1, 1886, outstanding liabilities	135 25	
		1,101 63
July 1, 1886, amount available		58,029 23
Amount appropriated by act approved August 5, 1886		37,500 00
Amount available for fiscal year ending June 30, 1887		95,529 23

Amount (estimated) required for completion of existing project	46,620 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	46,620 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 1.)

2. *Buffalo Harbor, New York.*—The original project for the improvement of this harbor was adopted in 1826, the date of the first appropriation, and, as modified at various times, provided for the construction of a north and south pier at the mouth of Buffalo Creek, a masonry sea-wall running south from the inner end of the south pier, and a breakwater less than half a mile in front of the Buffalo light-house, its long arm extending nearly parallel with the shore. The present project was adopted in 1874, and provides for the construction of a breakwater of crib-work 7,600 feet long, running parallel to the shore, and a shore-arm of pile and crib-work 4,100 feet long, running out towards the southern end of the main or detached breakwater, leaving an opening of about 150 feet between them.

The total amount appropriated for this harbor up to June 30, 1886, was $1,761,380.41, of which $1,684,424.67 have been expended, resulting in the construction of the north and south piers, the sea-wall, 870 linear feet of pile-pier, and 6,349.8 linear feet of main breakwater.

The northern portion of the main breakwater is very much in need of repairs.

The appropriation asked for is to be applied to extension and repair of the breakwater.

July 1, 1885, amount available		$59,453 94
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$50,123 74	
July 1, 1886, outstanding liabilities	122 53	
		50,246 27
July 1, 1886, amount available		9,207 67
Amount appropriated by act approved August 5, 1886		112,500 00
Amount available for fiscal year ending June 30, 1887		121,707 67

Amount (estimated) required for completion of existing project	$1,117,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	250,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 2.)

3. *Niagara River, New York.*—The project for this improvement was adopted in 1881, the object being the removal, by dredging, of the bars and removal of the submerged rocks in the channel in the neighborhood of Tonawanda Island.

The total amount appropriated for this work was $6,500, of which $5,912.48 have been expended, resulting in the formation of a channel of navigable width and a depth of 13 feet at low water. The natural channel was from 13 to 16 feet in depth, but narrowed by bars and rocks. All the work contemplated in this part of the river has been done.

July 1, 1885, amount available	$587 52
July 1, 1886, amount available	587 52

(See Appendix L L 3.)

4. *Wilson Harbor, New York.*—The project for the improvement of this harbor was adopted in 1873 and modified in 1877, the object being to afford a channel of navigable width and 12 feet in depth by the extension of the parallel piers, from the mouth of Twelve-Mile Creek to the 12-foot curve in the lake, with the formation of a protected channel between the piers. The mouth of the creek was originally obstructed by a bar, upon which there was a depth of about 1 foot.

Before the commencement of operations by the United States, the pier had been carried about 400 feet into the lake by private enterprise.

The existing channel between the piers has a depth of about 8 feet for a narrow width, while the depth of the inner harbor is even less.

The funds available for this harbor were practically exhausted during the fiscal year ending June 30, 1884, and no appropriation having been made by the act of July 5, 1884, no work has been done during the present fiscal year.

The amount expended to June 30, 1886, is $49,967.71, and has resulted in the extension of the piers to the 8-foot curve in the lake.

Any further appropriations will be applied to pier extension and maintenance, and such dredging as may be necessary.

July 1, 1885, amount available	$40 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8 11
July 1, 1886, amount available	32 29
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,032 29

Amount (estimated) required for completion of existing project	40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 4.)

5. *Olcott Harbor, New York.*—The project for the improvement of this harbor was adopted in 1866, the date of the first appropriation, and proposed to connect the deep water in the lake with the deep water in Eighteen-Mile Creek by the extension of two parallel piers from the mouth of the creek to the 11-foot curve in the lake with the formation

of a dredged channel between the piers. The project was modified in 1874 and 1881 to provide for the removal of rock found to exist in the channel between the piers, and for additional pier extension. The natural channel between the mouth of the creek and the lake was obstructed by a bar upon which there was a depth of about 1½ feet.

The last appropriation for this harbor was made March 4, 1881, and was expended in the construction of a shore-arm to the west pier. No work has been done during the present fiscal year.

The amount expended to June 30, 1885, is $118,000 and has resulted in the extension of the piers to about the 9-foot curve in the lake and the formation between the piers of a channel of navigable width, with a depth of about 7½ feet at low water.

Any further appropriation will be applied to pier extension and maintenance, and such dredging as may be necessary.

Amount appropriated by act approved August 5, 1886	10,000 00

Amount (estimated) required for completion of existing project	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 5.)

6. *Oak Orchard Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1836, the date of the first appropriation, and proposed the construction of an east and west breakwater, approaching to within 200 feet of each other, and connecting at this opening with parallel piers extending into the lake.

Subsequent modifications were extensions of the original project to provide for rock removal, and to adjust it to the increased demands of commerce. The present project was adopted in 1881, the object being to extend the piers to the 12-foot curve in the lake, with the formation of a channel of navigable width and 12 feet depth between the piers at low water. The natural channel of entrance into Oak Orchard Creek was narrow, with a depth of from 2 to 4 feet.

The total amount expended from 1836 to June 30, 1885, is $181,405.19, and has resulted in extending the piers to the 9-foot curve in the lake, securing a protected channel of navigable width and a depth of 9 feet at low water.

The amount expended since the adoption of the present project in 1881 is $7,905.19. No work was done during the year.

The appropriation asked for is to be applied to pier extension and maintenance, and such dredging as may be necessary.

July 1, 1885, amount available	$222 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	127 66
July 1, 1886, amount available	94 81
Amount appropriated by act approved August 5, 1886	12,500 00
Amount avilable for fiscal year ending June 30, 1887	12,594 81

Amount (estimated) required for completion of existing project	79,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 6.)

7. *Charlotte Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1828, the date of the first appropriation, and proposed to connect the deep water in the Genesee River with

The appropriation asked for is to be applied to the extension and maintenance of the piers and such dredging as may be necessary to maintain a channel through the outer bar.

July 1, 1885, amount available	$8,963 88
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,545 60
July 1, 1886, amount available	2,418 28
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	14,918 28
Amount (estimated) required for completion of existing project	32,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	16,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 10.)

11. *Oswego Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1827, and proposed to inclose an area at the mouth of the river by extending jetties from the shore into the lake, joining the outer ends by a breakwater, but leaving an opening through which to enter the harbor.

The project was completed in 1869 and forms the present inner harbor. The present project was adopted in 1870, and consists of a breakwater, 5,800 feet in length, parallel to the old west breakwater, and 1,100 feet in advance of it. The estimated cost was $1,161,682. It was modified in 1879, 1880, 1882, and 1883, by the proposed construction of an east breakwater 2,700 feet in length, the reduction of 350 feet of the opening between the east end of the west breakwater and the north end of the light-house pier, the use of creosoted timber in repairs to the old breakwater, the construction of spurs along the face of the outer west breakwater to reduce the effect of accumulated seas, and for deepening by dredging the inner harbor at the mouth of the Oswego River.

The object of these improvements was to give protection to the city docks and wharves, and to the commerce of the harbor and lake a depth suitable for the heaviest draught vessel on the lakes. The natural entrance to the mouth of the river was shallow and difficult of access.

The total amount expended from the date of the first appropriation in 1826 to June 30, 1886, is $1,564,158.20. The amount expended from the adoption of the present project in 1870 to June 30, 1886, is $1,090,795.33.

The total expenditure has resulted in the completion of the originally projected harbor, the completion of the west breakwater with the reduction of 350 feet of the opening between the east end of the west breakwater and the north end of the light-house pier, the construction of 213 linear feet of the east breakwater, the completion of one spur-crib, and the deepening of the river mouth to a depth of 15 feet at low water, securing full protection to the docks and wharves west of the river mouth and channels of entrance, 16 feet deep and 350 feet wide each, to the inner and outer harbors and 15 feet deep at low water. Early in December, 1884, a severe northwest storm caused a breach in the west breakwater 145 feet in width, and necessitating repairs for a length of 100 feet each side of the breach. This portion of the breakwater has been repeatedly breached, and in the opinion of the officer in charge the remaining old work should be entirely removed and rebuilt in a stronger manner, at an estimated cost of $80,000. The appropriation asked for includes the cost of repair of the breach and $70,682,

July 1, 1885, amount available	$177 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	175 00
July 1, 1886, amount available	2 90

(See Appendix L L 8.)

9. *Great Sodus Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1828; the first appropriation was made in 1829. The original project proposed the construction of two breakwaters, from the east and west shores, approaching to within 500 feet of each other, and connecting at this opening with parallel piers extending into the lake.

Subsequent modifications were extensions of the original project to adjust it to the increased demands of commerce. The present project was adopted in 1881, the object being to extend the piers to the 15-foot curve in the lake, and dredging a channel between the piers 15 feet deep at low water.

The natural channel would admit vessels drawing 8 feet at ordinary lake stage.

The total amount expended from 1829 to June 30, 1886, is $395,129.36. The amount expended from the adoption of the present project in 1881 to June 30, 1886, is $33,357.56.

The total expenditure has resulted in the extension of the west pier to the 14-foot curve in the lake, the extension of the east pier to the 9-foot curve in the lake, with a channel of navigable width, and 10 feet depth at low water between them.

The appropriation asked for is to be applied to pier extension and maintenance, and such dredging as may be necessary.

July 1, 1885, amount available	$6,770 14
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	5,130 70
July 1, 1886, amount available	1,639 44
Amount appropriated by act approved August 5, 1886	16,875 00
Amount available for fiscal year ending June 30, 1887	18,514 44
Amount (estimated) required for completion of existing project	48,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	24,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 9.)

10. *Little Sodus Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1829 and has since been variously modified.

The first appropriation was made in 1852.

The early project proposed the partial closing of the opening between the bay and the lake by lateral dikes connected with two parallel piers extending into the lake. The present project, which is an expansion of the earlier ones, was adopted in 1881, and is designed to afford a channel of navigable width of not less than 15 feet depth at low water.

The total amount expended from the date of the first appropriation in 1852 to June 30, 1886, is $267,023.49. The amount expended from the adoption of the present project in 1881 to June 30, 1886, is $32,581.72.

The total expenditure has resulted in the extension of the piers to the 12-foot curve in the lake, securing a channel between the piers of navigable width and 14 feet in depth, with a channel through the outer bar 12 to 14 feet deep at low water.

The appropriation asked for is to be applied to the extension and maintenance of the piers and such dredging as may be necessary to maintain a channel through the outer bar.

July 1, 1885, amount available	$8,963 88
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,545 60
July 1, 1886, amount available	2,418 28
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	14,918 28
Amount (estimated) required for completion of existing project	32,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	16,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 10.)

11. *Oswego Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1827, and proposed to inclose an area at the mouth of the river by extending jetties from the shore into the lake, joining the outer ends by a breakwater, but leaving an opening through which to enter the harbor.

The project was completed in 1869 and forms the present inner harbor. The present project was adopted in 1870, and consists of a breakwater, 5,800 feet in length, parallel to the old west breakwater, and 1,100 feet in advance of it. The estimated cost was $1,161,682. It was modified in 1879, 1880, 1882, and 1883, by the proposed construction of an east breakwater 2,700 feet in length, the reduction of 350 feet of the opening between the east end of the west breakwater and the north end of the light-house pier, the use of creosoted timber in repairs to the old breakwater, the construction of spurs along the face of the outer west breakwater to reduce the effect of accumulated seas, and for deepening by dredging the inner harbor at the mouth of the Oswego River.

The object of these improvements was to give protection to the city docks and wharves, and to the commerce of the harbor and lake a depth suitable for the heaviest draught vessel on the lakes. The natural entrance to the mouth of the river was shallow and difficult of access.

The total amount expended from the date of the first appropriation in 1826 to June 30, 1886, is $1,564,158.20. The amount expended from the adoption of the present project in 1870 to June 30, 1886, is $1,090,795.33.

The total expenditure has resulted in the completion of the originally projected harbor, the completion of the west breakwater with the reduction of 350 feet of the opening between the east end of the west breakwater and the north end of the light-house pier, the construction of 213 linear feet of the east breakwater, the completion of one spur-crib, and the deepening of the river mouth to a depth of 15 feet at low water, securing full protection to the docks and wharves west of the river mouth and channels of entrance, 16 feet deep and 350 feet wide each, to the inner and outer harbors and 15 feet deep at low water. Early in December, 1884, a severe northwest storm caused a breach in the west breakwater 145 feet in width, and necessitating repairs for a length of 100 feet each side of the breach. This portion of the breakwater has been repeatedly breached, and in the opinion of the officer in charge the remaining old work should be entirely removed and rebuilt in a stronger manner, at an estimated cost of $80,000. The appropriation asked for includes the cost of repair of the breach and $70,682,

Amount (estimated) required for completion of existing project........	$17,600 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 2.)

3. *Breakwater at Rouse's Point, Lake Champlain, New York.*—The project for this improvement was adopted in 1885, and contemplates the construction of a breakwater composed of rubble and large stone on a straight line extending from Stony Point in the general direction of the southern point of the 6-foot curve south of Windmill Point, until the 18-foot curve is reached, a total distance of about 2,000 feet.

The estimated cost of the breakwater is placed at $110,000.

Under a contract dated August 22, 1885, work was commenced on the breakwater September 1, since which time operations have progressed satisfactorily. This contract should be completed, according to its terms, by November 30, 1886, and comprises the construction of 800 linear feet, the shore section of the breakwater.

July 1, 1885, amount available..		$33,978 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885..........................	$7,590 71	
July 1, 1886, outstanding liabilities..........................	2,176 19	
		9,766 90
July 1, 1886, amount available..		24,211 27
Amount appropriated by act approved August 5, 1886....................		20,000 00
Amount available for fiscal year ending June 30, 1887....................		44,211 27

Amount (estimated) required for completion of existing project........	90,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 3.)

4. *Swanton Harbor, Vermont.*—The project for the improvement of this harbor was adopted in 1873, and had for its object the protection of anticipated docks and wharves by the construction of a breakwater in front of the place it was thought would be selected as their location.

The amount expended to June 30, 1886, is $70,188.07, and has resulted in the construction of the existing breakwater. Its site was necessarily selected before the docks there now were located, and the existing slight shipping facilities have unfortunately been located so that very little if any protection is received from it.

In the event of the general plan for the improvement of this harbor, as recommended after the examination and survey of 1884, being carried out, the officer now in charge recommends that such new work be placed about 200 feet further from shore than was favored by his predecessor two years ago; and, instead of curving in and joining the shore, he recommends the construction of two sections of breakwater, the one prolonging the present structure nearer to shore, the other starting at a point 200 feet north of the outer end of the present structure, to be extended on a line about parallel with the shore until directly west of the most northerly portion of the shipping in the harbor.

July 1, 1885, amount available..	$326 93
July 1, 1886, amount available..	326 93

Amount (estimated) required for completion of existing project........	169,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 4.)

5. *Plattsburg Harbor, New York.*—The first project for the improvement of this harbor was adopted probably in 1836, the date of the first ap-

propriation for it. That project and the modification of it, adopted and completed, have resulted in the construction of 1,250 feet of breakwater, the protection of a portion of the beach, and the dredging of shoal areas within the harbor.

The last modification, made in 1870, proposed the extension of the structure to the southeast, the protection of the adjacent beach by revetment and dredging. If, however, the plan of improving the mouth of Saranac River, Plattsburg, N. Y., as explained in the Annual Report for 1885, page 2319, should be carried out, it would constitute a further modification, by the enlargement of the area of dredging operations at this harbor.

Operations have been confined to dredging and repairs since 1875.

During the season of 1884 there were 3,022 cubic yards of material removed from shoal places near the docks, in order to afford sufficient depths for the steamboats frequenting the harbor, which consumed the available funds.

Some repairs to the breakwater and additional dredging are required.

The total amount expended to June 30, 1886, has been $138,411.94 of which amount $52,911.94 were expended since the adoption of the modified project in 1870.

The appropriation asked for is to be applied in dredging operations and repairs to the existing structure.

July 1, 1885, amount available	$88 06
July 1, 1886, amount available	88 06
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,088 06
Amount (estimated) required for completion of existing project	7,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 5.)

6. *Burlington Harbor, Vermont.*—The improvement of this harbor dates from 1836. Modifications of the original plan have occurred from time to time, so as to afford adequate protection to the increase of the commercial and shipping interests at the harbor.

The officer now in charge has submitted a plan for the further extension of the breakwater, both to the north and to the south, which awaits consideration before action can be taken on it.

Operations during the past year have been confined to repairs to the existing structure by the renewal of old and decayed portions of the superstructure, which were liable to become breached, and by raising it for 300 feet at the northern end, so as to be above high-water level.

The total amount expended to date is $479,969.89.

As additional funds become available they will be applied in further extensions of the breakwater, so as to keep pace with the growth of the commerce and the extension of the line of docks and wharves, and in repairing such old portions of the existing structure as may from time to time require it.

July 1, 1885, amount available	$11,302 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,099 69
July 1, 1886, amount available	3,202 31
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	21,952 31

Amount (estimated) required for completion of existing project	$185,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 6.)

7. *Otter Creek, Vermont.*—The project for this improvement was adopted in 1872, and, as modified in 1882 and 1884, proposes the formation of a channel of navigable width and a least depth of 8 feet from Vergennes, Vt., to Lake Champlain.

No operations have been carried on since the improvement of Bull Brook Bend and vicinity, in 1884, whereby this obstruction, which had been most serious as it previously existed, was entirely removed, so as to afford a good channel 75 feet wide and 8 feet deep at low water.

There have been expended to June 30, 1886, $33,351.66.

Steamboat Landing, Sharkie's and Crittenden's Bends, and the mouth, should all be improved by widening and deepening the channels in order to carry out the scheme of improvement.

July 1, 1885, amount available	$648 34
July 1, 1886, amount available	648 34

Amount (estimated) required for completion of existing project	39,748 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 7.)

8. *Ticonderoga River, New York.*—The project for this improvement was adopted in 1881, its object being to afford a channel of navigable width and a least depth of 8 feet at low water from Ticonderoga Village to Lake Champlain, a distance of about 2 miles.

The original estimated cost of this improvement was $42,516, of which amount $10,000 have been appropriated and expended, and have resulted in an improved channel which is now 60 feet wide, except the upper 2,000 feet, only 30 feet wide, and affords a least depth of 6 feet.

To complete the scheme of improvement, this channel should be widened in its upper reach to 60 feet, and should be generally deepened.

The principal industry subserved by this improvement is the manufacture of pulp and paper from wood fiber, which requires the annual transportation of about 2,000 tons of coal and 10,000 cords of wood.

Amount appropriated by act approved August 5, 1886	$2,000 00

Amount (estimated) required for completion of existing project	30,516 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 8.)

PACIFIC COAST.

IMPROVEMENT OF THE HARBORS OF OAKLAND, WILMINGTON, AND REDWOOD, CALIFORNIA.

Officer in charge, Lieut. Col. G. H. Mendell, Corps of Engineers.

1. *Oakland Harbor, California.*—The project for this improvement was made in 1874, when there was about 2 feet at low water on the bar. It is intended to secure a ship-channel 18 to 20 feet deep at low water by jetties, dredging, and the introduction of tidal water of San Leandro

Bay. The developments of commerce following partial improvement have required some modifications of the original project, particularly in dredging the existing ship-channel. The jetties have also been brought above high-water mark, in order to keep out sand and to do away with cross-currents. The present maximum depth of ship-channel is 18 feet at high water, while the width varies from 100 to 300 feet.

The amount appropriated since 1874 is $934,600, and the amount expended $870,464.53.

The contract of October 4, 1884, in force at the beginning of the year, for dredging the tidal basin and depositing the spoil ashore behind embankments, was completed May 19. The amount for the year was 698,312 cubic yards, and for the contract 728,359 cubic yards. The year's operations increased the channel flow per second more than 400 cubic feet, which is more than 6 per cent. of the original flow.

The condition of the channels and jetties remains practically the same as at the beginning of the year. The narrow ship-channel in front of Oakland is buoyed, making navigation convenient.

The appropriation asked is to be applied to further increase of tidal prism as originally projected either by dredging the tidal basin or by beginning the excavation of the San Leandro Canal, or both, in case the amount granted is adequate.

The completion of mansonry remaining unfinished on the south jetty and some filling on the north slope of the north jetty are also to be undertaken under the next appropriation.

July 1, 1885, amount available		$99,311 33
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$95,175 86	
July 1, 1886, outstanding liabilities	5 76	
		95,181 62
July 1, 1886, amount available		4,129 71
Amount appropriated by act approved August 5, 1886		60,000 00
Amount available for fiscal year ending June 30, 1887		64,129 71
Amount (estimated) required for completion of existing project		879,929 20
Amount that can be profitably expended in fiscal year ending June 30, 1888		250,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix N N 1.)

2. *Wilmington Harbor, California.*—The present project is intended to secure 14 to 16 feet depth at low water. The present low-water depth is 10 feet. Before the improvement was begun there was practically no navigation, the low water being only 1 foot. Vessels drawing 15 feet can now enter the harbor at high water. The greater part of the coasting trade of the port is now done in the harbor. Increase of depth is to be attained by dredging and by enlarging and extending the jetties, which operations need to be carried on together.

The operations of the past year consisted in completing the dike 600 feet in length, built for the purpose of protecting the southern end of Rattlesnake Island, and in completing the stone-work of the east jetty. The contract for stone in force at the beginning of the year was completed October 31, including a total delivery of 17,295 tons, of which 12,011 were delivered during the present year. The dike required 5,610 tons of stone. Its action has been favorable in collecting large deposits of sand at the southern end of the island. The main east jetty is now all above the level of high-water. The depth and dimensions of the interior channels have been slightly increased during the year, whil the depth at the entrance has remained practically unchanged.

The application of future appropriations will be in dredging and in extending and raising the west jetty and contingencies.

The total amount appropriated for this harbor is $780,000, and th amount expended $703,519.40. The amount appropriated for the enlarged project is $150,000 and the amount expended $148,519.40.

July 1, 1885, amount available		$40,166 8
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$38,686 25	
July 1, 1886, outstanding liabilities	85 00	
		38,771 2
July 1, 1886, amount available		1,395 6
Amount appropriated by act approved August 5, 1886		75,000 0
Amount available for fiscal year ending June 30, 1887		76,395 6
Amount (estimated) required for completion of existing project		175,000 0
Amount that can be profitably expended in fiscal year ending June 30, 1888		100,000 0

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix N N 2.)

3. *Redwood Harbor, California.*—The improvement of this harbor ha not been begun, the appropriation of $3,000 in the act of July 5, 188 being regarded as insufficient for purpose of making a contract.

The character of the contemplated improvement is to dredge a narro channel about 1 mile long in the bed of Redwood Slough to a depth o 3 feet, so as to give 7 feet at high water. This depth will fairly accommodate the small vessels which carry on commerce with San Francisc and other towns on the bay. It is intended to apply the money alread appropriated and that asked for to contracts for dredging.

The trade to be accommodated is local, taking in a fertile belt o country adjoining Redwood City, the amount of which trade in 188 was in excess of $1,000,000.

July 1, 1885, amount available	$3,000 0
July 1, 1886, amount available	3,000 0
Amount appropriated by act approved August 5, 1886	5,000 0
Amount available for fiscal year ending June 30, 1887	8,000 0
Amount (estimated) required for completion of existing project	7,400 0
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,400 0

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix N N 3.)

4. *Removal of sunken vessels or craft obstructing or endangering navigation.*—An examination of the wreck Escambia, made in April an May, 1886, discovered the fact that there is but 4½ fathoms of wate over portions, and that the wreck has been much broken by the sea an the fragments displaced. The last examination gave 5½ fathoms, whic is the general depth in the channel. With this depth over it the wrec was not considered to be a danger. The present condition is, howeve a danger to vessels.

A contract was made, after advertisement, on June 29 for the removal of the boilers and of such other portions of the wreck as promise to be dangerous. It is expected that the removal will be effected during the present summer.

The Escambia is an iron ship which foundered on San Francisco Bar in the fairway channel on June 19, 1882.

(See Appendix N N 4.)

IMPROVEMENT OF THE HARBOR OF SAN DIEGO, CALIFORNIA.

Officer in charge, Col. C. S. Stewart, Corps of Engineers.

The object of the improvement is to prevent this harbor from being the place of deposit of the materials brought down by the San Diego River during floods.

In 1875 a project was formed to turn the river back into one of its former outlets in the False Bay. This was carried into effect in 1876. From a point in the river-bed near Presidio Hill a new water-way was cut across the plain to a slough from False Bay. The old channel was closed. A levee faced with stone and extending from high land to high land was built along the artificial cut and between it and the harbor of San Diego, to restrain the river overflow in floods.

The improvement has thus far been a success.

The injuries to the levee from all causes has been so slight during the year that no repairs to it have been made. It is in fair order.

The sum of 95 cents has been expended in the fiscal year.

The total expenditure from the beginning of the improvement, to include June 30, 1886, amounts to $80,451.45.

The money still available from the appropriation for repairs made in 1879 will probably suffice for several years.

July 1, 1885, amount available	$549 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	95
July 1, 1886, amount available	548 55

(See Appendix O O.)

IMPROVEMENT OF ENTRANCE TO HUMBOLDT BAY; OF SAN JOAQUIN, MOKELUMNE, SACRAMENTO, AND FEATHER RIVERS, CALIFORNIA; AND OF COLORADO RIVER, NEVADA, CALIFORNIA, AND ARIZONA.

Officer in charge, Capt. A. H. Payson, Corps of Engineers. Supervising Engineer, Lieut. Col. G. H. Mendell, Corps of Engineers.

1. *Humboldt Harbor and Bay, California.*—The project for the improvement of the Bay was adopted in 1881, and had for its object to secure by dredging a channel 13 feet deep at low water and 200 feet wide to the upper end of Eureka wharves with channels 100 feet wide and 10 feet deep at low water to Arcata and Hookton. This project was supplemented in 1882, after investigation by a Board of Engineers, to seek a fixed position and increased depth for the channel across the bar by a training-wall to level of low water extending from the south spit in a northwesterly direction. The bay channels in their unimproved condition had minimum depths of 7 feet to Eureka and 6 feet to Arcata and Hookton.

The channel across the bar varied widely in position and in depth from 8 to 16 feet at low water. The amount expended to June 30, 1885, was $80,027.32, all in dredging and in examinations bearing on proposed improvement of bar channel.

In June, 1884, the dredging had resulted in securing the desired depths in the bay channels, but in the lack of recent surveys it is impossible to give their present condition precisely. The channel to Arcata is reported as maintained, but along the front of Eureka wharves and across the shoal below a shoaling of some 3 feet is thought to have taken place. No work has been done during the year ending June 30, 1886, as the sum available did not justify the beginning of so costly and exposed a work as the proposed jetty.

The amount estimated for completion of existing project could, in the opinion of the officer in charge, be most advantageously expended if all appropriated in two successive years. The land on the south spit which will be needed has been held at an exorbitant price by the owners, and will probably have to be condemned.

July 1, 1885, amount available	$62,472 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	109 04
July 1, 1886, amount available	62,363 64
Amount appropriated by act approved August 5, 1886	75,000 00
Amount available for fiscal year ending June 30, 1887	137,363 64
Amount (estimated) required for completion of existing project	462,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	200,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P P 1.)

2. *San Joaquin River, Stockton and Mormon sloughs, California.*—The project was originally adopted in 1877, the object being to obtain by dredging a channel 100 feet wide, and 6 feet deep at low water in the tidal parts of the river below Stockton, and to cut off the points at certain sharp bends.

This project was modified in 1881 to seek the maintenance of a channel 9 feet deep at low water, and 100 feet wide through Stockton Slough and the tidal river below; a channel 4 feet deep at low water, and 80 feet wide in Mormon Slough to Miller's Warehouse, the straightening of the river below mouth of Stockton Slough by cut-offs at certain sharp bends, and the temporary improvement of the low-water channel of the Upper San Joaquin by removal of snags, scraping of bars, and construction of wing-dams.

The tidal parts of the river below Stockton in their natural condition afforded a channel of practical width and 6 feet deep at low water. The upper river to Hill's Ferry was only navigable for boats drawing 2 feet during six to seven months in each year.

The amount expended to June 30, 1885, was $105,633.93 in dredging, and $33,812.45 in snagging and temporary measures on the upper river.

The balance of funds permitted no work during the fiscal year ending June 30, 1886, other than an examination of the crevasse at Paradise Cut.

The desired tidal channels below Stockton can only be maintained by annual dredging, and, as this has been remitted for two seasons, they have now reverted to their natural condition, except in Stockton and Mormon sloughs, where the original natural depths have been seriously impaired by the influx of sediment with land drainage. With the coming low water it is probable that not more than 4 feet can be taken to Stockton.

The cut-offs have maintained themselves and been of substantial benefit to the navigation. The sums available and asked for are to be applied, in the order named, to fitting dredge now under contract with centrifugal pump discharge, dredging below Stockton, removal of snags in the upper river, partial closure of Paradise Cut, and cut-offs at Twenty-one Mile Slough and Head Reach.

The estimated cost of completion of project is exclusive of the dredging and snagging, which will be a yearly necessity.

July 1, 1885, amount available	$553 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	35 32
July 1, 1886, amount available	518 28
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	19,268 28
Amount (estimated) required for completion of existing project, exclusive of dredging	139,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P P 2.)

3. *Mokelumne River, California.*—The present project for improvement was adopted in the autumn of 1884, and has for its object to clear the river of snags and overhanging trees from the mouth to Benson's Ferry.

The natural channel in this part of the river had depths of from 5 feet to 10 feet. The amount expended to June 30, 1885, in work by the United States snag-boat was $4,958.09, and resulted in a practicable channel by the north fork for the steamers in use as far up as Benson's Ferry.

During the fiscal year ending June 30, 1886, there has been expended also in work by the snag-boat over the same part of the river the sum of $3,499.39, resulting in the removal of 324 snags and 394 trees, and increased convenience for the navigation. With the sum of $5,000 asked for it is proposed to continue the work of snagging and clearing of banks to Benson's Ferry and possibly a little above, and to clear about 2 miles at the head of the south fork, which is the only part of it not now navigable.

As the project contemplates annual work as necessary, hence no estimate can be given of the sum required for completion.

July 1, 1885, amount available	$3,541 91
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,499 39
July 1, 1886, amount available	42 52
Amount appropriated by act approved August 5, 1886	2,500 00
Amount available for fiscal year ending June 30, 1887	2,542 52
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P P 3.)

4. *Sacramento and Feather rivers, California.*—The project was adopted in 1874 with the object of temporary improvement of the low-water channel by wing-dams and scraping and removing of snags, annually carried on by contract.

This was modified in 1879 to provide for the construction of a snag-boat and barge, and the further prosecution of the work by hired labor.

Up to June 30, 1885, there had been expended $221,750.53, of which $43,554 was for the building of a boat and barge, and $178,196.53 in actual work upon the river. During the year ending June 30, 1886, there was expended $25,346.99 in the removal of 650 snags and 139 trees, with 37 days spent in scraping crests of bars and 27 days in dam building.

The channel of the Sacramento before improvement offered a depth of 3½ feet as far as Jacinto, and 2½ above that to Chico Landing; but these depths were not available on account of snags.

The result of work has been to secure safe channels with these depths above the mouth of the Feather, and marked decrease in accidents to the navigation.

The river, below the mouth of Feather, which has deteriorated since improvement was undertaken from the inflow of detritus from the mines, last season offered greater difficulty to navigation than ever before.

The snag-boat is now in her sixth season and will need hereafter extensive annual repairs.

With the sums available, and asked for, it is proposed to continue work as before with the snag-boat.

The work being an annual necessity, no estimate can be given for a final completion.

Of the annual expenditures this fiscal year $2,000 was paid to the contractors for the new dredge.

July 1, 1885, amount available		$220,511 35
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$24,608 87	
July 1, 1886, outstanding liabilities	6,509 72	
		31,118 59
July 1, 1886, amount available		189,392 76
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		40,000 00

(See Appendix P P 4.)

NOTE.—The river and harbor act of August 5, 1886, directs that the balance of unexpended moneys for this improvement shall not be used until the Secretary of War be satisfied that hydraulic mining, hurtful to navigation, has ceased on these rivers and their tributaries.

5. *Colorado River, Nevada, California, and Arizona.*—A project for improvement was adopted October, 1884, the object being to afford a channel of practicable width and 3 feet in depth from Camp Mojave to El Dorado Cañon during six months in each year, by hired labor.

The river in its unimproved condition was navigable with some difficulty for 2½ feet draught throughout the year from its mouth to Camp Mojave, but from thence to El Dorado were numerous rapids and some sunken rocks with less than 1 foot of water. The worst obstructions were at Hatteras Bar, Six Mile Rapid, and Mojave Crossing.

The amount expended to June 30, 1885, was $15,741.59, and resulted in a permanent improvement to the desired limits, and Six Mile Rapid by the removal of sunken bowlders, and a partial improvement at Mojave Crossing by the closure of a side channel.

During the year ending June 30, 1886, there has been expended $9,077.95 and the result has been an increase in the low-water depths at Mojave Crossing from 1 foot to 3 feet, and at Hatteras Bar from 1 foot to 2 feet.

Explorer's Rock, above El Dorado Cañon, was removed from 1 foot above low water to 1 foot below, and is no longer an obstacle at stages when navigation in this part of the river is possible. Contracted channels were widened at Bull's Head Cañon and Bowlder Rapid, and a side channel closed at Pest House Rapid.

The effect of work thus far, in the opinion of steamboatmen, has been to make navigation to El Dorado Cañon practicable for about five months in each year.

The appropriation is exhausted and no work is proposed for the coming fiscal year.

In the lack of detailed surveys of the river no precise estimate of cost of completing original project can be made.

July 1, 1885, amount available	$9,258 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,077 95
July 1, 1886, amount available	180 46

(See Appendix P P 5.)

IMPROVEMENT OF UPPER AND LOWER COLUMBIA AND WILLAMETTE RIVERS; OF THE SNAKE, COWLITZ, AND YAMHILL RIVERS, OREGON AND WASHINGTON; AND OF LOWER CLEARWATER RIVER, IDAHO—CONSTRUCTION OF CASCADES CANAL, COLUMBIA RIVER.

Officer in charge, Maj. W. A. Jones, Corps of Engineers, with Lieut. Willard Young, Corps of Engineers, under his immediate orders. Supervising Engineer, Lieut. Col. G. H. Mendell, Corps of Engineers.

1. *Columbia and Willamette rivers below Portland, Oregon* (in charge of Capt. C. F. Powell, Corps of Engineers, to March 31, 1886).—The project for this improvement was adopted in 1877, and modified subsequently; the object being to afford a ship-channel of 20 feet depth at low water, by contraction and shore-protection works at four bars from Portland to Columbia City, by temporary improvement at the bars during construction of the works, and at three shoal places below Columbia City, and by snagging operations.

The natural depth of channel at the shoalest place was about 9 feet, and on six other bars 10½ to 15 feet at low water. The amount expended on the project to June 30, 1886, is $373,755.06, and has resulted generally in maintaining a channel depth of successively 17, 18, and 19 feet, low water, from Astoria, near the mouth of the Columbia River, to Portland, 100 miles distant inland.

Operations during the year consisted of sounding and surveying bars, ballasting dike at Saint Helen's; willow plantations above shore-protection works; repairs to tug Lincoln, and care and protection of property and plant.

The amount asked for the next fiscal year is for completion of the project of contraction and shore-protection works, temporary improvement during the year, extension of the plan of permanent works below Columbia City, and for removal of a rock obstruction. Amount expended to June 30, 1886, is $373,755.06.

July 1, 1885, amount available	$506 28
Received during fiscal year ending June 30, 1886, from transfer of property to other appropriations	2,530 35
	3,036 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,036 12
July 1, 1886, amount available	51
Amount appropriated by act approved August 5, 1886	75,000 00
Amount available for fiscal year ending June 30, 1887	75,000 51

Amount (estimated) required for completion of existing project	332,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	150,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q Q 1.)

2. *Upper Willamette River, Oregon.*—The project for this improvement was adopted in 1870, modified in 1878, and extended in later years. The object is to afford and maintain an easy light-draught navigation from Portland to Eugene City, and on 12 miles of tributaries, making in all a distance of 184 miles.

The work consists of snagging operations, bar scraping, and for the reach between Willamette Falls and Corvallis, in the contraction of water-way by low cut-off or wing-dams and rock removal. The natural channel from Portland to Willamette Falls, 12 miles, was generally deep and wide. Above it is narrow, tortuous, and much obstructed. The mouth of the Yamhill, 28 miles from the falls, was the head of an inconvenient low-water navigation in a draught of 2½ feet. Only 1 foot could be carried above. The present project was adopted in 1878. Total appropriation to August 5, 1886, $84,000. Amount expended, $73,984.52, of which about $22,000 has been applied to construction, and the remainder to maintenance.

Operations for the year have been work with the snag-boat and construction of wing-dams.

The amount asked for is to be applied to rock removal, river-construction works, and annual maintenance.

July 1, 1885, amount available	$3,394 72
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,379 24
July 1, 1886, amount available	15 48
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,015 48

Amount (estimated) required for completion of existing project	29,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	29,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q Q 2.)

3. *Columbia River at Cascades, Oregon.*—The plan for this improvement, adopted in 1877 and modified in 1880, is to give lockage around the main rapid and open river navigation through the minor rapid below, from low water up to a stage of about 20 feet, at the foot of the canal. The plan contemplates the construction of a guard-lock for use at the higher stages. The canal will be about 3,000 feet long. The low-water lock will have a lift of about 24 feet. The lock capacity will be 90 feet by 462 feet, with a least draught of 8 feet. Amount expended to June 30, 1886, is $951,450.25. During the year work has been carried on in the excavation for canal and lock-pits, grading grounds, quarrying stone from bowlders, completion of cement-shed, repairs of plant and quarters, repairing road for wagon-portage, construction of scow, water-guage observations, and care and protection of plant and property.

The appropriation asked for is to be applied to construction of wing-walls, lock-walls, guard-gate, purchase of timber for gates, lock and canal-pit excavation, and grading.

July 1, 1885, amount available		$21,823 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$18,273 92	
July 1, 1886, outstanding liabilities	776 82	
		19,050 74
July 1, 1886, amount available		2,772 93
Amount appropriated by act approved August 5, 1886		187,500 00
Amount available for fiscal year ending June 30, 1887		190,272 93
Amount (estimated) required for completion of existing project		1,100,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		400,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Q Q 3.)

4. *Upper Columbia and Snake rivers, Oregon and Washington Territory.*—The plan of this improvement, adopted in 1877, consists in rock removal at a number of very swift rapids to give channel depths at low water of 5½ feet in the Columbia and 4½ feet in Snake River, a river length of 266 miles between Celilo on the Columbia and Lewiston on the Snake. The natural channel was narrow, tortuous, and dangerous, with many very difficult rapids.

Amount expended to June 30, 1886, is $113,550.90, and has resulted in improvement at fifteen localities. All work has been done by contract, but has been very much impeded by bad weather and accidents. The rapids are very strong and work is difficult and dangerous.

Rock removed during year, 58.45 cubic yards. Gravel and cobblestone removed during the year, 587.04 cubic yards.

It is proposed to apply the appropriation asked for to the removal of rocks and cobble-stone bars to complete the project.

July 1, 1885, amount available		$8,398 79
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,949 69	
July 1, 1886, outstanding liabilities	77 50	
		6,027 19
July 1, 1887, amount available		2,371 60
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		12,371 60
Amount (estimated) required for completion of existing project		26,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Q Q 4.)

5. *Cowlitz River, Washington Territory.*—The project for this improvement, adopted in 1880, consists in wing-dam construction, bar-scraping, and snagging operations, to secure light-draught navigation up to Toledo, a little more than 30 miles above the mouth.

The original estimate for this work was $3,000 for construction in the first year, and an annual expenditure thereafter of $2,000 for maintenance by snagging operations. Total appropriation to August 5, 1886, is $8,000. Amount expended to June 30, 1886, is $6,000.

During the year no work was performed, the appropriation having been practically exhausted in previous year.

July 1, 1885, amount available	$11 87
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11 87
Amount appropriated by act approved August 5, 1886	2,000 00

Amount (estimated) required for completion of existing project	3,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888, to include maintenance	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q Q 5.)

6. *Lower Clearwater River, Idaho.*—The present project, adopted in 1878, is to make a channel through rock-reefs and cobble-stone bars from Lewiston, at the mouth of the river, to North Fork, a distance of 40 miles, to secure a low-water channel depth of 4 feet.

The amount expended to June 30, 1884, is $15,000, and has resulted in improvement, more or less complete, over the lower reach of 30 miles.

Amount (estimated) required for completion of existing project	$19,424 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q Q 6.)

7. *Survey of Columbia River above the mouth of Snake River, Washington Territory.*—An allotment of $6,000 was made from the appropriation of July 5, 1884, for this work, and a project was duly approved for the applying this sum to a survey of Priest Rapids. The survey of the reach embraced by the Priest Rapids, a distance of 10.22 miles, and a rapid survey also made of Cabinet Rapids, 45 miles above, was made and completed within that sum.

A project is submitted by the officer in charge for opening the river to navigation by means of open-river improvement and the removal of submerged rock by blasting, with an estimate of the cost of the same, $153,240.

(See Appendix Q Q 7.)

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON TERRITORY; OF THE ENTRANCES TO COOS AND YAQUINA BAYS; OF MOUTH OF COQUILLE RIVER AND OF UMPQUA RIVER, OREGON; AND OF CERTAIN RIVERS EMPTYING INTO PUGET SOUND AND GRAY'S HARBOR, WASHINGTON TERRITORY—WATER-GAUGES ON COLUMBIA RIVER.

Officer in charge, Capt. Charles F. Powell, Corps of Engineers, with Lieut. Edward Burr, Corps of Engineers, under his immediate orders until October 20, 1885. Supervising Engineer, Lieut. Col. G. H. Mendell, Corps of Engineers.

1. *Mouth of the Columbia River, Oregon and Washington Territory.*—The project of this improvement, adopted in 1884, is to afford a channel 30 feet deep at mean low tide by a low-tide jetty, about 4½ miles long and of a partly tentative character, from near Fort Stevens, on the south cape, to a point about 3 miles south of Cape Disappointment.

The natural channel is generally divided; the bar channels are changeable in location and depth. Of late years the main channel has carried about 19 feet at low water, and for an insufficient width; 26 feet are required on the bar in a wide, direct, and stable channel, and 30 feet are desirable for the deep vessels needed by the Columbia River trade, on account of the heavy seas of the locality.

The amount expended on the project to June 30, 1885, is $59,376.70, and was for necessary preliminary work, building certain accessory structures and obtaining plant.

The amount expended during the fiscal year 1886 is $38,615.39.

The jetty, of a brush-mattress and stone ballast, was built for 1,020 feet from ordinary highest tide-line, and minor constructions added. A hydrographic survey was made.

The general effect of the jetty has been to cause the sands to fill against the south side and to move seaward, as expected, the shore-lines on that side. The work has not been far enough advanced to have any influence on the channel.

The improvement is important and of magnitude.

The appropriation asked for is to build part of 3 miles of jetty for closing a swash channel across Clatsop Spit, on which sand the jetty is to be built; this section of jetty is expected to considerably improve the ship-channel.

July 1, 1885, amount available		$34,362 98
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$32,355 07	
July 1, 1886, outstanding liabilities	574 30	
		32,929 37
July 1, 1886, amount available		1,433 61
Amount appropriated by act approved August 5, 1886		187,500 00
Amount available for fiscal year ending June 30, 1887		188,933 61
Amount (estimated) required for completion of existing project		3,422,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		700,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix R R 1.)

2. *Entrance to Coos Bay, Oregon.*—The project of this improvement, adopted in 1879, and subsequently extended, is to build a half-tide jetty, or deflecting dike, about 2,400 feet long, from near Fossil Point, inside, of the entrance, towards Coos Head, exterior to the entrance, for affording a direct channel of 14 feet depth at mean lower low water, and one less exposed to heavy seas and of easier access under storm winds than the ordinary natural channel. The mean rise of tide above the plane of reference is 5.6 feet. The natural channel sometimes carried not more than 7 to 8 feet low-water depth.

The amount expended on the project to June 30, 1885, is $124,953.48; it has resulted in the construction of 1,825 feet of incomplete jetty, partly in deep water, affording during the preceding four years a straighter and more stable channel by partly eroding the north spit, as desired, and deflecting the ebb about one half from its former direction towards that intended.

The amount expended during the year, June 30, 1886, is $3,305.77. A hydrographic survey was made and minor quarry operations conducted. The channel has considerably further improved during the year.

The appropriation asked for is to extend the jetty and to raise the present submerged part to low tide.

July 1, 1885, amount available		$3,758 78
Amount received by transfer of property to other improvements		10 78
		3,769 56
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,999 64	
July 1, 1886, outstanding liabilities	231 67	
		3,231 31
July 1, 1886, amount available		538 25
Amount appropriated by act approved August 5, 1886		33,750 00
Amount available for fiscal year ending June 30, 1887		34,288 25
Amount (estimated) required for completion of existing project		436,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		100,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix R R 2.)

3. *Entrance to Yaquina Bay, Oregon.*—The project of this improvement is to build a brush-mattress and stone jetty about 4,000 feet long on the south side of the entrance, with shore protection, to close a rock-obstructed channel, for providing a central free channel of 12 feet depth at mean lower low water. A shorter jetty on the north side was proposed for future consideration. The mean rise of tide above the plane of reference is 7.1 feet.

Of three natural channels of a best depth of 7 to 10 feet reduced, two of them are obstructed by dangerous rocks.

The amount expended on the project to June 30, 1885, is $152,247.41, and has resulted in the construction of 2,517 feet of jetty and 450 feet of shore protection. For the greater part of the time since the first considerable work the channel has been deeper and removed from the south rocks. The channel is now in about the desired position and has a low-water depth of 11 feet.

The amount expended during the year June 30, 1886, is $2,852.49.

A survey of June, 1886, was mapped, and an investigation made of the advisability of extending the project to give a greater depth of water than now contemplated, for a discussion of which see reports of the engineer in charge and supervising engineer in Appendix.

July 1, 1885, amount available		$4,180 72
Amount received by transfer of property to other improvements		98 37
		4,279 09
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,587 49	
July 1, 1886, outstanding liabilities	53 87	
		2,641 36
July 1, 1886, amount available		1,637 73
Amount appropriated by act approved August 5, 1886		75,000 00
Amount available for fiscal year ending June 30, 1887		76,637 73
Amount (estimated) required for completion of existing project		96,970 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		200,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix R R 3.)

4. *Mouth of Coquille River, Oregon.*—The plan of this improvement, adopted in 1880, is to afford a direct free channel 10 feet deep at mean lower low water, by a half-tide jetty or deflecting dike about 3,400 feet

long, built from the left bank and passing 800 feet south of the Rackliff Rock. The mean rise of tide above the reference plane is 4 feet.

The natural channel was long, tortuous, shoal, and rendered extremely dangerous by numerous rocks.

The amount expended on the project to June 30, 1885, is $27,455.28, and has resulted in the construction of a jetty 1,523 feet long, but not of full strength. The channel projected by the improvement was opened four year ago, and has since been maintained with but little variation in position and depth; it is short, direct, free from dangerous rocks, and about double the depth of the former channel.

The amount expended during the year June 30, 1886, is $414.13. Periodical examinations of the jetty and channel were made, and a construction building repaired to render secure property stored therein.

The amount asked for is to extend the jetty and make it permanent by heavy ballast and riprap.

July 1, 1885, amount available		$329 81
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$104 94	
July 1, 1886, outstanding liabilities	27 00	
		131 94
July 1, 1886, amount available		197 87
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,197 87

Amount (estimated) required for completion of existing project	114,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R R 4.)

5. *Umpqua River, Oregon.*—The project of this work is to apply the balance of the appropriation of the act of March 3, 1871, in rock removal at five reefs near and below Scottsburg for a low-water channel 3 feet deep by 50 feet wide, for aiding small screw-vessel navigation from Scottsburg down-stream.

Previous to the year June 30, 1886, no work had been done on the river below Scottsburg. During that year $3,891.89 were expended on the project. The Scottsburg reefs, including a rock shoal below the lower reef were drilled and, except the upper reef, blasted.

It is proposed with the balance on hand to remove the broken rock, which will afford a channel about 2 feet low-water depth. One thousand dollars are asked for completing the 3-foot channel through the Scottsburg Reefs. The engineer in charge estimates the cost of a needed 4-foot channel from Scottsburg to Gardiner, near the mouth of the river, at $30,000.

July 1, 1885, amount available		$4,685 89
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,891 89	
July 1, 1886, outstanding liabilities	73 47	
		3,965 36
July 1, 1886, amount available		720 53

Amount (estimated) required for completion of existing project	1,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	1,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R R 5.)

6. *Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Washington Territory.*—The project of the improvement for these rivers, adopted in 1882, consists in annual snagging and moderate bar scraping by a regularly equipped snag-boat for light-draught navigation to the natural heads thereof, being an aggregate length of river of about 250 miles.

The natural channels are deep in the tidal sections, shoal and generally rapid in the upper portions, and much obstructed by drift throughout.

The amount expended on the project to June 30, 1885, is $29,984.39, and has permitted partial work on four of the five rivers covered by the project. There were no expenditures during the year ending June 30, 1886.

The amount asked for is to complete the construction and appliances of the snag-boat, operate her on each of the rivers named, reserving $4,000 for a fund for rebuilding the boat at the end of ten years.

July 1, 1885, amount available, inclusive of outstanding liabilities	$15 61
July 1, 1886, outstanding liabilities	135 00
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	9,880 61
Amount (estimated) required for continuing existing project	29,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R R 6.)

7. *Chehalis River, Washington Territory.*—The project of this improvement, adopted in 1882, consists in annual snagging operations below Claquato, 82 miles from the river's mouth, at an estimated cost of $5,000.

The lower river, 12 miles from Montesano, the head of coasting navigation, to Gray's Harbor is free of bad snags. From Montesano to Elma, the head of tide, 16 miles, the river is considerably obstructed by snags, and from Elma to Centralia, on the Northern Pacific Railroad, it was practically blocked by 3 drift-jams and numerous snags. Above that to Claquato the river is tolerably free.

The expenditures on the project to June 30, 1885, are $5,004.93. A passage was cut through the jams and some snags removed as far as Elma, but yet not making navigation practicable. No operations were conducted during the year.

Since previous work was partial, drift has accumulated from a long suspension of operations.

July 1, 1885, amount available		$495 07
Amount received by transfer of property to other improvements and by deposit		23 04
		518 11
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$147 42	
July 1, 1886, outstanding liabilities	360 00	
		507 42
July 1, 1886, amount available		10 69
Amount appropriated by act approved August 5, 1886		2,500 00
Amount available for fiscal year ending June 30, 1887		2,510 69

Amount (estimated) required for continuing existing project	8,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R R 7.)

8. *Gauging waters of the Columbia River and principal tributaries.*—The object here is to operate an automatic gauge at Astoria and maintain staff-gauges above, for pilots' information and for record of tides and stages of river, one service of the Astoria gauge being to show the condition of the bar at the mouth of the Columbia River with regard to roughness. It is also intended to measure the tidal and river volumes. The amount expended therefor to June 30, 1886, is $1,495.27; it has permitted partial service of water-gauges, but none in measuring the water-volumes.

During the last year the Astoria gauge was operated for part of a month. Four staff-gauges, for pilots' use on the Lower Columbia, were renewed and similar gauges established at eight places near bars on that river or on the Lower Willamette. Float-gauges were fixed at Columbia City and Coffin Rock, Lower Columbia; day-time highest and lowest waters were observed at these places, and at Saint Helen's for part of the year and at North Portland for all the year. The service was much curtailed for lack of funds.

July 1, 1885, amount available	$210 24
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	205 51
July 1, 1886, amount available	4 73
Amount appropriated by act approved August 5, 1886	1,000 00
Amount available for fiscal year ending June 30, 1887	1,004 73
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix R R 8.)

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS.

For examinations and surveys, for improvements and for contingencies, and for incidental repairs of harbors for which there is no special appropriation, an appropriation of $150,000 should be made, of which sum $50,000 for surveys and $100,000 for contingencies, including incidental repairs of harbors.

PUBLIC WORKS, APPROPRIATIONS FOR WHICH ARE NOT INCLUDED IN RIVER AND HARBOR ACTS.

MAINTENANCE AND REPAIRS OF WASHINGTON AQUEDUCT—INCREASING WATER-SUPPLY OF THE CITY OF WASHINGTON—ERECTION OF FISH WAYS AT THE GREAT FALLS OF THE POTOMAC.

Officer in charge, Maj. G. J. Lydecker, Corps of Engineers, with Capt. Thomas W. Symons, Corps of Engineers, under his immediate orders to April 16, 1886.

1. *Washington Aqueduct.*—The appropriation of $20,000 has been applied as usual, mainly to the routine work involved in the care of the

aqueduct and distribution of the water-supply. A large break in the 36-inch supply main caused a serious reduction in the amount of water flowing into the city during a period of thirty-six hours, the time required for making the repairs.

Near the inlet to the aqueduct at the Great Falls a new masonry discharging-weir was built through the bank of the Chesapeake and Ohio Canal, and the old discharging-weir and two waste-weirs were closed up, the object being to secure the water flowing into the aqueduct from danger of pollution by the waters in the adjoining canal level.

The amount required for the expenses of the aqueduct and its appurtenances for the fiscal year ending June 30, 1888, is $20,000. In addition, the officer in charge of the work renews his recommendation of last year in relation to certain improvements at the Receiving Reservoir and at the Great Falls, which are designed to secure the water-supply against all danger of contamination from surface drainage. The estimated cost of the work is, in round numbers, $125,000, and the appropriation of this sum is commended to the favorable consideration of Congress, in view of the importance of doing everything possible to insure a delivery of the Potomac water in its purest natural condition.

July 1, 1885, amount available		$20,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$18,969 13	
July 1, 1886, outstanding liabilities	1,030 87	
		20,000 00
Amount appropriated by act approved June 30, 1886		20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00

(See Appendix S S 1.)

2. *Increasing the water-supply of Washington, D. C.*—The approved project for this work comprises, first, the extension of the dam at the Great Falls of the Potomac across Conn's Island and the Virginia Channel to the Virginia shore, and the completion of the whole to an elevation of 148 feet above mean high tide at the navy-yard, this elevation being about 15 inches above the crest of the old dam across the Maryland Channel of the river; second, the extension of the aqueduct by a tunnel about 20,700 feet long, from the terminus of the conduit at Drovers' Rest (Distributing Reservoir) to the site of a new reservoir near Howard University; third, construction of a new reservoir at that place capable of holding about 300,000,000 gallons; fourth, making the necessary main connections for taking the water from the new reservoir into the system of supply-mains for the city.

Contracts for the dam, tunnel, and reservoir were made in the fall of 1883, and operations have been in progress under these contracts since that time.

It was expected that work on the *dam* would be completed in the fall of 1885, but the contractors, having experienced considerable trouble on account of high water, did not succeed in so doing, and the work was carried over into the past spring. At the close of the fiscal year it had been completed with the exception of about 192 linear feet of coping. The whole work will be finished during the present season.

On the *tunnel* the work of excavation in the several headings aggregated 13,500 linear feet, of which 745 linear feet were lined with masonry, at the commencement of the last fiscal year. Operations were continued until February 1, 1886, when it became necessary to suspend work because the appropriation was about exhausted, the balance then available being only $1,571.93, and this was held to protect the tunnel from damage by flooding during the suspension of work, pending action in Congress in relation to the additional appropriation that had been asked for in the last annual report and again urgently recommended in a special communication that was forwarded to Congress by the Secretary of War, under date of January 15, 1886 (published as House Ex. Doc. No. 39, Forty-ninth Congress, first session). Action was delayed, however, until this balance was exhausted, whereupon Congress made a special supplementary appropriation of $5,000 to continue pumping operations. At the close of the fiscal year this appropriation was reduced to $231.03. Since then the general deficiency bill has passed both houses of Congress, and contains the necessary appropriation for resuming work (but the bill has not, at this writing, become a law).

The length of excavation accomplished during the fiscal year was 5,040.2 linear feet, and 745 linear feet of tunnel was lined with masonry, making the total length of excavation 18,538.2 feet, or about 3½ miles, of which 1,490 feet was lined with masonry. The excavation is now *continuous* for a distance of 16,327 feet, or a little over 3 miles, from the west end of the tunnel. There remains a distance of about 2,150 feet to be excavated, when the tunnel will be "holed" through from end to end. The sum named in the general deficiency bill for continuing this work is $395,000, and operations will be resumed as soon as it becomes available. The above amount was that estimated as necessary to complete the tunnel before the suspension of operations; but the officer in charge of the work is of opinion that the ultimate cost of completion will be increased as the direct result of the suspension, which has now lasted for a period of six months; but he is unable to submit any estimate of the probable amount of increase until after a thorough examination, and that cannot be made until work on the tunnel is resumed.

Work on the *reservoir* was continued during the year, but the progress has been slow; the principal feature of the work is the excavation of about 850,000 cubic yards of earth and its embankment to form a massive dam, and the laying of about 76,000 square yards of dry stone paving on the slopes of the reservoir and dam. On the 30th of June, 1886, the total amount of excavation was 727,329 cubic yards, and of paving 39,414 square yards, of which 232,033 cubic yards of excavation and 19,722 square yards of paving was done during the past fiscal year; during the same time about 3,700 linear feet of masonry conduits or sewers, for intercepting the flow of storm-waters, sewage, &c., were constructed. The general deficiency bill contains an item of $160,000 for continuing the work, and this, it is believed from all that can now be foreseen, will be sufficient to complete the work in all its essential features.

Nothing of moment was done on the *main connections* during the past fiscal year, this part of the work having been completed during the preceding year, so far as anything can be done until the effluent gate-house is constructed at the reservoir, when the outlet-main, 75 inches in diameter, will be connected with that structure. The balance available for this purpose is $2,847.48, and will probably be sufficient.

There has been expended to June 30, 1886, for *land damages, water rights*, and *damages to Chesapeake and Ohio Canal*, the sum of $248,152.19, of which $15,189.51 applies to the past fiscal year.

July 1, 1885, amount unexpended		$615,310 81
Amount appropriated by act approved March 26, 1886		5,000 00
		620,310 81
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$380,162 66	
July 1, 1886, outstanding liabilities, including retained percentages	116,119 24	
		496,281 90
July 1, 1886, amount available		124.028 91
Amount appropriated by act approved August 4, 1886		555,000 00
Amount available for fiscal year ending June 30, 1887		679,028 91

(See Appendix S S 2.)

3. *Erection of fish-ways at Great Falls.*—The project for this work provides for building, in the Maryland Channel or Falls Branch of the Potomac River, a fish-way in six sections, in accordance with detailed plans and specifications that were prescribed by the United States Commissioner of Fish and Fisheries, in pursuance of the act of Congress approved July 15, 1882.

Active operations were commenced in June, 1885, under contract executed towards the end of the preceding month, and continued until the close of October; at that time a flood in the river carried away the protecting dams, destroyed one section of the fish-way, and caused damage to the others that were in process of construction, the precise extent of which is as yet unknown, for the reason that they have remained submerged since that date. Operations were then suspended and the contract terminated, in pursuance of the recommendation of the officer in charge of the work, who is of the opinion that they were not planned with sufficient strength to resist the effect of floods in that locality.

No estimate is submitted at this time for completing the work, for the reason that no intelligent computation of the cost can be made until the flow of water which now submerges the damaged portions has been diverted and the extent of damages determined. Steps to accomplish this have been taken, and the matter will be made the subject of special report and estimate at a later date.

July 1, 1885, amount unexpended	$47,640 12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	38,263 81
July 1, 1886, amount available	9,376 31

(See Appendix S S 3.)

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS IN THE DISTRICT OF COLUMBIA.

Officer in charge, Lieut. Col. John M. Wilson, Corps of Engineers, colonel, U. S. A.

At the Executive Mansion, the entire old copper roof, which leaked badly, was removed and replaced with first-quality dipped Martin-Siemens steel roofing-plates; the area thus covered was about 18,000 square feet; the fifty-nine telegraph wires which were stretched across the roof were removed during the year; the conservatory and greenhouses were painted, and minor repairs made to the mansion, greenhouses, and stables.

A new plant-house and two new brick cold-frames were erected, and numerous minor repairs and improvements made to the greenhouses and grounds at the nurseries.

In addition to the work performed for maintaining in good condition the improved public reservations, extensive improvements were made at Washington Circle, Garfield Park, Smithsonian and Seaton parks, and at the South Carolina Avenue reservation.

Water-pipes were laid and water introduced into sixteen reservations. Five unimproved reservations were improved during the year, as follows:

One at corner of Massachusetts avenue and Twenty-first street, northwest.

One at corner of Massachusetts avenue and Fifth street, northwest.

One at corner of New Jersey avenue and Second street, northwest.

One at corner of Pennsylvania avenue and Ninth street, southeast.

One at corner of Pennsylvania avenue and Tenth street, southeast.

The officer in charge has endeavored to distribute the new improvements made through various sections of the city.

Attention is invited to the detailed report of the officer in charge, and to his estimates and recommendations for the fiscal year ending June 30, 1888. His estimates are as follows:

For improvment and care of public grounds	$170,500
For compensation of persons employed upon public buildings and grounds	51,100
For replacing the overhead system of telegraph wires with duplicate six-conductor underground cable, and for care and repair of lines	10,000
For copying the original map of Washington City	400
For contingent and incidental expenses of the Office of Public Buildings and Grounds	500
For rent of Office Public Buildings and Grounds	900

(See Appendix T T.)

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES

1. *Bridge across the Mississippi River at Keithsburg, in the State of Illinois.*—The plan and location of this bridge, authorized by act of April 26, 1882, were approved by the Secretary of War, July 6, 1885, on condition that certain modifications be made thereto, and having been modified accordingly, were finally approved October 13, 1885.

(See Appendix U U 1.)

2. *Stone arch bridge across the west channel of the Mississippi River at Minneapolis, Minnesota.*—In consequence of representations made to the War Department, that the construction of this bridge, proposed to be built by the city of Minneapolis, under authority of the legislature of Minnesota, might imperil not only the expensive works constructed by the United States for the preservation of the Falls of Saint Anthony, but ultimately destroy the falls themselves, at the request of parties interested, and in view of the contrariety of opinion existing in relation thereto, a Board of Engineer Officers was constituted to examine the subject and report its conclusions.

The report of the Board was duly submitted to the War Department and returned to this office, with opinion that there not appearing to be any injury probable to the works constructed by the General Government at the falls by the erection of the proposed bridge, in view of the opinion of the Attorney-General of May 1, 1885, in the matter of the railroad bridge at Saint Paul, the Secretary of War has no authority upon other grounds to interfere with or to regulate the construction.

(See Appendix U U 2.)

3. *Proposed bridge on the Ohio River, at or near Cairo, Illinois.*—The Committee of Commerce of the House of Representatives having trans-

mitted, with request for suggestions of the War Department, bill H. R. 6047, Forty-ninth Congress, first session, "to authorize the Chicago, Saint Louis and New Orleans Railroad Company and the Illinois Central Railroad Company, or either of them, to construct a bridge at or near Cairo, Illinois," in view of the great importance of the interests involved and the difficulty and expense attending the construction of a bridge at the locality proposed, it was deemed expedient, with the sanction of the Secretary of War, to refer the bill in question to a Board of Engineer Officers for examination and report.

The Board, after giving the subject full investigation and study, reached the unanimous conclusion "that no modification of the act approved February 14, 1883," [supplementary to the act of December 17, 1872, prescribing the dimensions of bridges across the Ohio River], "can be recommended which would tend to lessen its requirements, and especially that prescribed in the final proviso of section 2, which fixes a clear height of 53 feet above local highest water, measured to the lowest part of the channel-span, as the minimum for a continuous bridge without a draw."

The Board also "unanimously decided to report adversely to the construction of a draw-bridge at Cairo." * * * "A low draw-bridge with clear headway of only 15 feet at high water, with openings on each side of 160 feet in the clear, as proposed in the bill, is regarded by the Board as entirely inadmissible. Such a bridge would be an intolerable obstruction to navigation at all boating stages, and, in the opinion of the Board, should not be seriously considered."

The conclusions of the Board were concurred in by the Chief of Engineers and by the War Department and printed as House Mis. Doc. No. 339, Forty-ninth Congress, first session.

(See Appendix U U 3.)

4. *Bridge of the Selma Bridge Company across the Alabama River at Selma, Alabama.*—Representations having been made that this bridge, which was being built, would be likely to create an obstruction to the navigation of the Alabama River, the subject was referred, with the approval of the Secretary of War, to a Board of Engineer Officers for consideration, with instructions to report its recommendations, having in view the requirements of section 8 of the river and harbor act of July 5, 1884.

The Board in its report, March 25, 1886, regarded the bridge in question a serious obstruction to navigation, and recommended that the Selma Bridge Company be required to prepare a channel for the passage of boats, between the pivot-pier and the north bank of the river, for all stages of water exceeding a 24-foot stage; with the understanding that, if at any time in the future, it should be necessary to provide further facilities for navigation, the bridge company shall then be required to alter and change the bridge, at its own expense, in such manner as may be proper to secure free and complete navigation without impediment.

The recommendation of the Board was concurred in by this office and by the War Department.

(See Appendix U U 4.)

5. *Changes in the original plan of the bridge across the Ohio River at Henderson, Kentucky.*—This bridge, as constructed, differs in plan from that recommended September 24, 1881, by a Board of Engineer Officers,

and approved by the Secretary of War October 11, 1881, as appears in annual report of this office for 1882, page 1989.

There being nothing in print to show when and in what manner the changes were authorized, the correspondence relating thereto is inserted in the appendix of this report for convenience of reference, and to complete the printed record.

(See Appendix U U 5.)

6. In consequence of provisions of section 2 of the river and harbor act of July 5, 1884, which require the Secretary of War to report to Congress whether any bridges, causeways, or structures, erected or being erected, interfere with free and safe navigation, and if so, to report the best mode of altering or constructing them, with the view of supplying the information desired, officers under direction of this office were instructed to submit reports covering all facts necessary to enable the Secretary of War to comply with the terms of the act. A communication containing reports received in compliance with these instructions, and comprising all instances reported to this office up to date of interference with free and safe navigation by bridges and other structures, was transmitted to the Senate December 18, 1885, and printed as Senate Ex. Doc. No. 12, Forty-ninth Congress, first session.

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTHWESTERN LAKES.

Under the supervision of this office the following engraved copper-plates of charts of the Northern and Northwestern lakes have been electrotyped:

Lake Michigan Coast Chart No. 4, Niagara Falls.

The following charts have been photolithographed and an edition printed:

Buffalo Harbor, scale $\frac{1}{15000}$.
Erie Harbor, scale $\frac{1}{15000}$.
Saint Lawrence River Detail Sheets Nos. 1, 2, 3, 4, 5, and 6, scale $\frac{1}{10000}$.

During the year 4,537 charts were issued under the supervision of Lieut. Col. O. M. Poe, Corps of Engineers, 1,212 of which were sold at 30 cents each, and the amount, $363.60, turned into the Treasury.

Amount appropriated by act approved March 3, 1885	$3,000 00
June 30, 1886, amount expended during the fiscal year	2,544 04
Amount available for the fiscal year 1886–'87	2,000 00
Amount required for survey of Northern and Northwestern lakes for fiscal year ending June 30, 1888, namely, for printing and issuing charts for the use of navigators, and electrotyping copper-plates for chart-printing.	2,000 00

MILITARY AND GEOGRAPHICAL MAPS.

The following maps have been photolithographed and an edition printed:

Map of the Department of Dakota, scale $\frac{1}{1500000}$, by Lieut. John Biddle, Corps of Engineers, 1886.

Preliminary sketches of sheets 3, 4, 7, 8, and 12 of survey of Western Texas, scale 1 inch to 4 miles, by Maj. W. R. Livermore, Corps of Engineers, 1884.

Map of a portion of Southeastern Arizona, scale 8 miles to 1 inch, by Lieut. E. J. Spencer, Corps of Engineers, 1886.

Map of part of Turkey in Europe, in seven sheets.

Map of the Arkansas River from Little Rock to its mouth, in 22 sheets, scale 1 inch to 2,400 feet, made under the direction of Capt. H. S. Taber, Corps of Engineers, 1886, Map of the United States and Texas boundary line, determined and surveyed in 1857-'58-'59-'60, by J. H. Clark, United States Commissioner; scale, $\frac{1}{1000000}$.

The compilation of a map of Central America on a scale of $\frac{1}{1250000}$ has been commenced and considerable progress made.

The compilation of a map of the United States on a scale of $\frac{1}{2000000}$ has been commenced.

Amount appropriated by act approved March 5, 1885	$5,000 00
June 30, 1886, amount expended during the fiscal year	910 55

RECONNAISSANCES AND EXPLORATIONS.

The following officers of the Corps of Engineers have been on duty at the headquarters of the Army and at the divisions and departments, engaged in preparing such maps and making such surveys as were required by their respective commanding officers:

Capt. James F. Gregory, lieutenant-colonel and aid-de-camp to the Lieutenant-General at headquarters of the Army, to October 10, 1885.

Maj. Thomas H. Handbury, at headquarters Division of the Missouri.

Maj. W. R. Livermore, at headquarters Department of Texas, to March 15, 1886.

Capt. D. C. Kingman, at headquarters Department of the Platte.

Lieut. Eugene Griffin, at headquarters Division of the Atlantic and Department of the East, from September 7, 1885, to May 29, 1886.

Lieut. Thomas L. Casey, at headquarters Division of the Pacific and Department of California.

Lieut. Theodore A. Bingham, at headquarters Department of Arizona, to August 13, 1885; Lieut. E. J. Spencer, from February 1, 1886, to date.

Lieut. John Biddle, at headquarters Department of Dakota.

Lieut. Edward Burr, at headquarters Department of the Columbia, from October 22, 1885.

Maj. T. H. Handbury, engineer officer headquarters Military Division of the Missouri, reports that his work has consisted in collecting geographical information for the improvement of existing maps, and in making copies of maps of military posts, scouts, reconnaissances, and of military and Indian reservations for use at division headquarters.

Capt. D. C. Kingman, engineer officer, headquarters Department of the Platte, reports that he has surveyed and plotted a tract of 80 acres of land lying north and northwest of Fort Omaha, with a view to its purchase by the Government for a rifle range, surveyed and re-established the southern boundary of the military reservation at Fort D. A. Russell; also surveyed and set out a rifle range at Bellevue, Nebr. A map of the department is being compiled under his direction.

Captain Kingman has also been engaged in the construction of roads and bridges in the Yellowstone National Park, in accordance with the provisions of an act of Congress approved March 3, 1883.

Lieut. T. L. Casey, engineer officer, Division of the Pacific and Department of California, reports that operations have been carried on as follows:

Triangulation of proposed rifle ranges for skirmish firing on the Presidio Reservation, photographing military implements, copying, enlarging, and reducing maps and drawings by photography, and the preparation of a new map of the Department of California. In addition to his duties as engineer officer of the division and department he has performed the duties of inspector of rifle practice for the Department of California, and by order of the President, dated War Department, Adjutant-General's Office, Washington, September 24, 1885, was detailed as one of the commission to run and mark the boundary line between a portion of the Indian Territory and the State of Texas, in connection with a similar commission to be appointed by the State of Texas.

Lieut. John Biddle, engineer officer of Department of Dakota, reports the survey of the boundary line of Fort Buford Military Reservation by Lieut. J. E. Wilson, Fifth Infantry, also an examination and report by the same officer of the irrigating ditches at the Indian Agencies at Poplar Creek and Wolf Point, Montana Territory, also a reconnaissance made by himself from Fort Shaw, Montana, to the Jocko Indian Agency and return, to ascertain the practicability of the mountain passes in that vicinity. A new map of the Department of Dakota has been completed, photolithographed, and distributed throughout the department. New information is being collected of the country surrounding the various military posts in the department.

Lieut. Edward Burr, engineer officer Department of the Columbia, entered upon his duties October 22, 1885, relieving acting engineer officer Capt. J. W. MacMurray, First Artillery, and reports that operations have been carried on as follows:

A boat reconnaissance of Pend d'Oreille River from Sand Point, Idaho Territory, to the mouth of Sullivan's Gulch, Washington Territory, was made during the month of August, 1885, by Lieut. W. R. Abercrombie, Second Infantry. Lines of levels were run upon the Vancouver Military Reservation in connection with the sewerage system, contour map, and for road and building purposes. A survey of the old roads in the timber reserve was made, and new roads located in the post reserve. The work of revision of the progress sheets of the department has been continued. Plans were prepared for new and proposed buildings for the Quartermaster's Department. New plans of occupied posts in the department, on a small scale, are being prepared for publication. A large number of drawings, tracings, and blue prints have been made for the use of the Quartermaster's Department, Chief Ordnance Officer, and other staff officers, during the year.

Lieut. T. A. Bingham, engineer officer department of Arizona, from July 1, 1885, to August 13, 1885. Capt. C. W. Williams, assistant quartermaster, acting engineer officer from August 13, 1885, to November 6, 1885. Capt. J. F. Weston, commissary of subsistence, acting engineer officer from November 6, 1885, to February 1, 1886. Lieut. E. J. Spencer, engineer officer, February 1, 1886. During portions of the months of February and April, and the month of March, Lieutenant Spencer was engaged in a compass and odometer survey of Cochise and the eastern portion of Pima counties in Arizona. This work was plotted and a map prepared on a scale of 4 miles to 1 inch.

ESTIMATE FOR AMOUNT REQUIRED FOR SURVEYS AND RECONNAISSANCES IN MILITARY DIVISIONS AND DEPARTMENTS.

For military surveys and reconnaissances and surveys of military reservations by the engineer officers attached to the several headquarters of military divisions and departments, being an average of $5,000 for each of eight military divisions and departments west of the Mississippi River, $40,000; for publication of maps for use of the War Department, $10,000; total, $50,000.

OFFICE OF THE CHIEF OF ENGINEERS.

In the labors of the office the Chief of Engineers was assisted on the 30th of June by the following officers in charge of the several divisions:

Lieut. Col. John M. Wilson, colonel, U. S. A.

FIRST DIVISION.—*Fortifications and Surveys relating thereto—Armament of Fortifications—Sites for Engineer Defenses—Boards of Engineers for Defenses.*

SECOND DIVISION.—*Battalion of Engineers—Engineer School of Application and Engineer Depot and Post—Professional Papers and Information—Personnel—Orders—Military Reservations—Land Files.*

Col. John G. Parke, brevet major-general, U. S. A.

THIRD DIVISION.—*Improvement of Rivers and Harbors and Surveys relating thereto—Bridging Navigable Waters of the United States—Public Buildings and Grounds and Washington Aqueduct.*

Capt. Henry M. Adams.

FOURTH DIVISION.—*Accounts for Disbursements—Contracts—Returns of Engineer Property and Instruments—Applications for Remittances—Appropriations and Estimates—Blank Forms.*

FIFTH DIVISION.—*Survey of the Lakes—Explorations and Surveys—Reconnaissances—Maps—Instruments—Claims.*

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

HON. WILLIAM C. ENDICOTT,
Secretary of War.

STATEMENT SHOWING THE RANK AND THE DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR ENDING JUNE 30 1886.

RANK AND NAME.	DUTIES.
BRIGADIER-GENERAL AND CHIEF OF ENGINEERS.	
John Newton *Bvt. Major-General.*	In command of the Corps of Engineers and in charge of the Engineer Department. Charged with the supervision of such matters connected with construction of jetties and other works at South Pass, Mississippi River, as require the action of the Secretary of War In charge of the removal of obstructions in the East River and Hell Gate, N. Y. Member of Joint Commission to supervise the construction of the Washington National Monument. Directed by the President to co-operate with the authorities of the State of New York in examining and deciding upon exterior pier and bulkhead lines on Hudson River from State dam at Troy to the city of Hudson. Member of the Lighthouse Board. Member of Board of Officers and Civilians to examine and report at what ports fortifications or other defenses are most urgently required, &c.
COLONELS.	
Charles S. Stewart	In charge of the construction of Fort Winfield Scott, and batteries at Fort Mason, and fortifications at Angel Island in San Francisco Bay, and at San Diego, Cal. In charge of the improvement of the harbor at San Diego, Cal. Senior member of Board of Engineers for the Pacific Coast.
Charles E. Blunt	In charge of Forts Knox, Popham, Gorges, Scammel, McClary, and batteries at Portland Head and Gerrish's Island, Me., and Fort Constitution and battery at Jerry's Point, N. H., and of construction of Fort Preble, Me. In charge of the improvement of the harbors at Bangor, Belfast, Rockland, and Portland, Me., and Portsmouth, N. H. In charge of the improvement of the rivers Penobscot and Kennebunk, Me., and Cocheco, N. H., Saco River Breakwater, Lubec Channel, and Moose-a-bec Bar, Me. In charge of preliminary examination and of survey of Saco River. To take steps towards the removal of wreck of schooner Waldemar in Belfast Harbor, Me. Supervising Engineer over districts embracing works in charge of Majors Smith, Overman, and M. B. Adams, and Captain Maguire.
James C. Duane *Bvt. Brig. General.*	Member and President of the Board of Engineers. Senior member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Engineer 3d Lighthouse District. Member of Board of Engineer Officers for the examination of certain officers of the Corps with view to their promotion.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
Orlando M. Poe........ *Bvt. Brig. General.*	In charge of the construction of Fort Wayne, Mich. In charge of the improvement of the harbors at Cheboygan and Au Sable on Lake Huron and Alpena at Thunder Bay, and of the construction of harbor of refuge on Lake Huron; of the improvement of the Saint Mary's Falls Canal and River, and of the rivers Detroit, Saginaw, and Clinton, Mich., and Hay Lake Channel of the Saint Mary's River; of removing bar at ice-harbor of refuge at Belle River, Mich.; and construction of dry-dock, Saint Mary's Falls Canal. In charge of Saint Clair Flats Canal and Saint Mary's Falls Canal, Mich. In charge of issuing charts of Northern and Northwestern Lakes, and of water-level observations on Lake Huron. In charge of preliminary examination and of survey of Saint Clair River. To cause plans, estimates, and specifications for dry-dock, at the Saint Mary's Falls Ship Canal, above the locks, and also to report whether the old locks can be used for a dry-dock, and the cost of fitting the same for that purpose. Member of Boards of Engineer Officers on plan for lock and dam at Grand Rapids, Wabash River; on proposed bridge across the Mississippi River at Minneapolis, &c., and on bridge over the Ohio River at or near Cairo, Ill.
David C. Houston ..... *Bvt. Colonel.*	Supervising Engineer of the districts embracing works in charge of Majors Damrell and Heuer, and Captains Hoxie and Rossell. Member of Board of Engineer Officers to consider question of construction of a bridge over the Alabama River at Selma, Ala. Member of the Board of Engineers. In charge of Forts Griswold and Hale, Conn., and Lafayette, N. Y., and of the construction of Forts Trumbull, Conn., and Columbus and Wood, N. Y.; Castle Williams, South Battery, new Barbette Battery and Sea-wall at Governor's Island, N. Y., and of permanent platform for modern canon of large caliber. In charge of the improvement of the harbors of New London, Clinton, New Haven, Milford, Bridgeport, Black Rock, Southport, and Norwalk, Conn., and Port Jefferson, Greenport, Mamaroneck, East Chester, New Rochelle, and of Echo Harbor, N. Y., and of the construction of breakwater at New Haven, Conn. In charge of the improvement of the rivers Housatonic and Thames, Conn., Connecticut, Mass. and Conn., Flushing Bay, and East Chester Creek, N. Y. In charge of the manufacture and supply of Mastic. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Representing the General Government in the erection of a pedestal for the statue of Liberty Enlightening the World upon Bedloe's Island, N. Y. H. In temporary charge of Fort at Sandy Hook, N. J., and of the construction of Fort Hamilton and additional batteries and Mortar Battery at Fort Hamilton, N. Y. In temporary charge of the improvement of the harbors of Rondout and Saugerties, N. Y., and Keyport, N. J. In temporary charge of the improvement of the Hudson and Harlem rivers, N. Y.; Shrewsbury, Rahway, Elizabeth, Manasquan South, Raritan, and Passaic rivers, N. J.; Sheepshead and Canarsie bays, N. Y., Raritan Bay, N. J.; channel in Gowanus Bay and Buttermilk Channel, N. Y.; channel between Staten Island and New Jersey, and deepening Gedney's Channel, N. Y.; Woodbridge, Cheesequakes, and Mattawan creeks, N. J., Newtown Creek and Sumpawanus Inlet, N. Y. In temporary charge of the removal of obstruction

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	in East River and Hell Gate, N. Y. Member of Board of Engineer Officers for the examination of certain named officers of the Corps with view to their promotion.
George H. Elliot	In charge of the Forts at Clark's Point, Mass., and Dutch Island, R. I., and of the construction of Fort Adams, R. I. In charge of the construction of Harbor of Refuge at Wood's Holl, Mass. In charge of the improvement of the harbors of Nantucket, Wood's Holl, Wareham, and Hyannis, Mass., Newport and Block Island, R. I., and Stonington, Conn. In charge of the improvement of the rivers Taunton, Mass., Pawtucket and Providence and Narragansett Bay, R. I., and Little Narragansett Bay, R. I. and Conn. Member of Advisory Council to the Rhode Island State Board of Harbor Commissioners. To take steps for removal of wrecks of steamer Perkiomen, Nantucket Sound, Mass., and of sunken schooner lying off Point Judith, R. I.
Henry M. Robert	In charge of Forts Delaware, Del., and Mifflin, Pa., Fort and Mortar Battery opposite Fort Delaware, Del., and battery and mortar battery at Finn's Point, N. J. In charge of the improvement of the harbor at Delaware Breakwater; Ice-harbors at Marcus Hook, Pa., and the head of Delaware Bay; of the Salem, Rancocas, and Raccoon rivers, and Cohansey, Mantua, and Woodbury creeks, N. J.; Frankford Creek, Schuylkill River, and north branch of the Susquehanna River, Pa.; Delaware River below Bridesburg, Pa.; between Bridesburg and Trenton; near Cherry Island flats; at Schooner ledge; and from Trenton, N. J., to its mouth; and of the construction of pier near Lewes, Del. Member of Commission Advisory to Board of Harbor Commissioners of Philadelphia. In charge of preliminary examination and of survey of Maquam Bay, Swanton, Vt. In charge of preliminary examination of the mouth of Salmon River, and inner natural harbor thereat, on Lake Ontario, N. Y. In charge of the removal from Delaware River of wrecks of steam canal-boat Thomas Carroll, schooners Estella Bright and Annie, and of wreck of ship Adolphus lying off Cape Henlopen, Del.
William E. Merrill..... *Brt. Colonel.*	In charge of the improvement of the Ohio River; the Falls of the Ohio; the Louisville and Portland Canal, and Harbor of Refuge near Cincinnati, Ohio. In charge of the improvement of the Monongahela River, W. Va. and Pa.; of the Allegheny River, Pa., and of the construction of Ice-harbors at mouth of Muskingum River, Ohio, and mouth of Great Kanawha River, W. Va. In charge of preliminary examination of Muskingum River, Ohio. Engineer 14th Lighthouse District. Member of Boards of Engineer Officers on plan for a lock and dam at Grand Rapids, Wabash River, and on project for improvement of Black Warrior River, Ala.
Walter McFarland.....	In charge of Forts Griswold and Hale, and of the construction of Fort Trumbull, Conn. In charge of the improvement of the harbors of New London, Clinton, New Haven, Milford, Bridgeport, Black Rock, Southport, and Norwalk, Conn., and Port Jefferson, Greenport, Mamaroneck, Rondout, Port Chester, New Rochelle, Saugerties, and of Echo Harbor, N. Y., and of the construction of breakwater at New Haven, Conn. In charge of the improvement of the

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	rivers Housatonic and Thames, Conn., Connecticut, Mass. and Conn., Hudson and Harlem, and Buttermilk Channel, Channel in Gowanus Bay, Flushing Bay, and Newtown Creek, N. Y. In charge of the removal of obstructions in East River and Hell Gate. In charge of removal of wreck of schooner Jane at mouth of New Haven Harbor, Conn. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Member of Board of Engineer Officers on subject of permanent improvement of Delaware River and Bay. In charge of Fort Lafayette, N. Y., and Fort at Sandy Hook, N. J., and of the construction of Forts Columbus, Wood, and Hamilton and additional batteries Castle Williams, South Battery, new Barbette Battery, and Sea-wall at Governor's Island, and Mortar Battery at Fort Hamilton, N. Y. In charge of the improvement of Keyport Harbor, N. J. In charge of the improvement of the Shrewsbury, Rahway, Elizabeth, Manasquan, South, Raritan, and Passaic rivers, Raritan Bay, and Woodbridge, Cheesequakes, and Mattawan creeks, N. J.; Sheepshead and Canarsie bays, Sumpawanus Inlet, and East Chester Creek, N. Y., and channel between Staten Island and New Jersey, and deepening Gedney's Channel, N. Y. In charge of the manufacture and supply of Mastic.
John M. Wilson .... *Bvt. Colonel.*	In charge of the 1st and 2d Divisions, Office of the Chief of Engineers. In charge of Public Buildings and Grounds in the District of Columbia, with the rank of colonel.
John W. Barlow	In charge of the improvement of the harbors at Ontonagon, Eagle Harbor, Marquette, Manistique, and Cedar River, Mich., Menomonee, Green Bay, Ahnapee, Two Rivers, Manitowoc, Sheboygan, Port Washington, Kewaunee, Pensaukee, and Oconto, Wis.; and harbors of refuge at entrance to Sturgeon Bay Canal, Lake Michigan, and Grand Marais, Mich. In charge of water-level observations on Lake Superior. Advisory Engineer for improvement of Kewaunee Harbor, Wis. In charge of the improvement of the rivers Tennessee, Tenn., Ala., and Ky., Cumberland above and below Nashville, Ky., and Tenn., Hiawassee, Caney Fork, Duck, French Broad, Clinch, and Little Tennessee, Tenn., and South Fork of the Cumberland, Ky.
MAJORS.	
Peter C. Hains......... *Bvt. Lieut. Colonel.*	In charge of Forts Foote and Washington, Md. In charge of the improvement of the harbors at Washington and Georgetown, D. C. In charge of the improvement of the Potomac River in the vicinity of Washington, D. C., the establishment of the harbor lines, and the raising of the river flats. In charge of the improvement of James River, Va., and Shenandoah River, W. Va. Member of Board of Engineer Officers on improvement of Potomac River in vicinity of Washington, D. C.
George L. Gillespie .... *Bvt. Lieut. Colonel.*	In charge of Fort Lafayette, N. Y., and Fort at Sandy Hook, N. J., and of the construction of Forts Columbus, Wood, and Hamilton and additional batteries, Castle Williams, South Battery, new Barbette Battery, and Sea-wall at Governor's Island, and Mortar Battery at Fort Hamilton, N. Y. In charge of the improvement of Keyport Harbor, N. J. In charge of the improvement of the Shrewsbury,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	Rahway, Elizabeth, Manasquan, South, Raritan, and Passaic rivers, Raritan Bay, and Woodbridge, Cheesequakes, and Mattawan creeks, N. J.; Sheepshead, and Canarsie bays, Sumpawanus Inlet, and East Chester Creek, N. Y., and channel between Staten Island and New Jersey, and deepening Gedney's Channel, N. Y. In charge of the manufacture and supply of Mastic. In charge of the removal of the wreck of steamer Nankin at entrance to New York Harbor. To represent the General Government in the arrangement for, and the erection of, a pedestal to be built to receive the colossal bronze statue of Liberty Enlightening the World, to be erected upon Bedloe's Island, N. Y. H. In charge of preliminary examination and of survey of Hudson River, New Jersey side, from Weehawken to Bergen Point. Member of Board of Engineer Officers on subject of permanent improvment of Delaware River and Bay. Member of Board of Officers to determine whether the moneys raised and appropriated are sufficient to complete the proposed Bennington Battle Monument in accordance with the approved design. In charge of Forts Winthrop, Standish, Andrew, Independence, and work on Long Island Head, and of the construction of Fort Warren, Mass. In charge of the improvement of the harbors at Newburyport, Lynn, Boston (including sea-walls on Point Allerton, Great Brewster Island, Lovell's Island, Gallops Island, Long Island Head, Rainsford Island, and Deer Island; Mystic and Charles rivers; and channel leading to Nantasket Beach), Provincetown, Plymouth, and Scituate, Mass. In charge of construction of a national harbor of refuge (of the first class) at Sandy Bay, Cape Ann, Mass. In charge of the improvement of the rivers Merrimac and Malden, Mass.
Charles R. Suter	In charge of the improvement of the Missouri River from its mouth to Sioux City, Iowa. Member of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member and president of the Missouri River Commission, created by act of Congress approved July 5, 1884. Engineer 15th Lighthouse District.
Jared A. Smith	Engineer 5th and 6th Lighthouse Districts. In charge of Forts Knox, Popham, Gorges, Scammel, McClary, and batteries at Portland Head and Gerrish's Island, Me., and Fort Constitution and Battery at Jerry's Point, N. H., and of construction of Fort Preble, Me. In charge of the improvement of the harbors at Bangor, Belfast, Rockland, and Portland, Me., and Portsmouth, N. H. In charge of the improvement of the rivers Penobscot and Kennebunk, Me., and Cocheco, N. H., Saco River Breakwater, Lubec Channel, and Moose-a-bec Bar, Me. To take steps towards the removal of the wreck of the schooner Waldemar in Belfast Harbor, Me.
Samuel M. Mansfield, *Bvt. Lieut. Colonel.*	In charge of the improvement of the harbors at Galveston and Brazos Santiago, Tex. In charge of the improvement of ship channel in Galveston Bay, Pass Cavallo, Aransas Pass and Bay up to Rockport and Corpus Christi, Brazos River, Buffalo Bayou, deepening channel at mouth of Trinity River and removal of obstructions to Liberty, and the protection of river bank at Fort Brown, Tex. Engineer 10th and 11th Lighthouse Districts. Member of commission to run and mark the boundary lines between a portion of the Indian Territory and the State of Texas,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
William R. King.......	In charge of the improvement of the rivers Tennessee, Tenn., Ala., and Ky., Cumberland above and below Nashville, Ky. and Tenn., Hiawassee, Caney Fork, Duck, French Broad, Clinch, and Little Tennessee, Tenn., and South Fork of the Cumberland, Ky. In charge of preliminary examinations of Cumberland River above the mouth of Jellico and Holston River, Tenn., and extension of survey of Caney Fork River to Frank's Ferry, Tenn. Member of Boards of Engineer Officers on plan for a lock and dam at Grand Rapids, Wabash River, and on project for improvement of Black Warrior River, Ala. Commanding Battalion of Engineers. In charge of Torpedoes for harbor defense and the Engineer Depot at Willets Point, N. Y.
Wm. H. H. Benyaurd..	In charge of improvement of the harbors at Chicago and Calumet, Ill. In charge of the improvement of the Illinois and Calumet rivers. In charge of survey of the Hennepin Canal, and for enlargement of Illinois and Michigan Canal. In charge of preliminary examination and of survey of Calumet River, east of Hammond to the forks of the river.
Garret J. Lydecker	In charge of the Washington Aqueduct; increasing water supply of the city of Washington, and the erection of fishways at Great Falls of the Potomac River. Engineer Commissioner of the District of Columbia. Member of board of officers on plan of reservoir for additional water supply for the cities of Washington and Georgetown.
Amos Stickney.........	In charge of 4th District of the Mississippi River, from Warrenton to Head of the Passes, for the purpose of improvement and the construction and repair of levees, to include levees and special work on the river, the improvement of the harbor at New Orleans, the Mississippi River at Natchez and Vidalia, the mouth of Red River, and the rectification of the Red and Atchafalaya rivers at mouth of Red River. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. In charge of the Louisville and Portland Canal. In charge of the improvement of the Falls of the Ohio River, Wabash River, Ind. and Ill., and White River, Ind.
Alexander Mackenzie..	In charge of the improvement of the harbor at Rock Island, Ill. In charge of the improvement of the Mississippi River from Saint Paul to Des Moines Rapids; the Upper Mississippi River, and Rock Island Rapids and Des Moines Rapids of the Mississippi River; and of removing bar in Mississippi River opposite Dubuque, Iowa. In charge of the construction of a dry-dock at the Des Moines Rapids Canal; of ice-harbor at Dubuque, Iowa, and of harbors of refuge on Lake Pepin at Stockholm, Wis., and Lake City, Minn. In charge of operating the Des Moines Rapids Canal. Member of the Missouri River Commission, created by act of Congress approved July 5, 1884. Member of Boards of Engineer Officers on plan for lock and dam at Grand Rapids, Wabash River; on proposed bridge across the Mississippi River at Minneapolis, &c., and on bridge over the Ohio River at or near Cairo, Ill.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
Oswald H. Ernst	In charge of the improvement of Mississippi River between the mouths of the Illinois and Ohio rivers, opposite Saint Louis, Mo., and at Cape Girardeau, Mo., and Minton's Point, and the harbor at Alton, Ill. Member of the Missouri River Commission, created by act of Congress approved July 5, 1884.
David P. Heap	Detached; Engineer Secretary to the Lighthouse Board.
William Ludlow *Bvt. Lieut. Colonel.*	On leave of absence for one year from April 1, 1885, under provisions of joint resolution of Congress approved February 13, 1885. Detached; Engineer Commissioner of the District of Columbia.
William A. Jones	In charge of the improvement of the Columbia River at Cascades, Oreg., Upper and Lower Columbia and Snake rivers, Oreg. and Wash., Willamette River above Portland, and Lower Willamette River below Portland, Oreg., Cowlitz River, Wash., Yamhill River, Oreg., and Lower Clearwater River, Idaho. In charge of survey of Columbia River above mouth of Snake River, Wash.
Andrew N. Damrell	In charge of Forts Morgan and Gaines, Ala., and fort on Ship Island, Miss. In charge of the improvement of the harbor at Mobile, Ala. In charge of the improvement of the rivers Black Warrior, Ala., Pascagoula, Pearl, and Noxubee, Miss., Tombigbee, Ala. and Miss., the roadstead leading into Back Bay of Biloxi in Mississippi Sound, channel of Biloxi Bay, and Old Town Creek and Horn Island Pass, Miss. In charge of preliminary examinations and of surveys of Wacissa River, and Pascagoula River from the mills at Moss Point to the anchorage in the bay. Member of Boards of Engineer Officers to consider question of a bridge over the Alabama River at Selma, Ala., and on project for improvement of Black Warrior River, Ala.
Charles J. Allen	In charge of the improvement of the harbors of Duluth, Grand Marais, and Superior Bay, on Lake Superior. In charge of the improvement of the Chippewa River, and protection of sand-banks on the same; of the Minnesota and Saint Croix rivers, and the Red River of the North; of the Mississippi River above the Falls of Saint Anthony; of the Falls of Saint Anthony; construction of Meeker's Island lock and dam, and lock and dam at Goose Rapids on Red River of the North. In charge of the construction of reservoirs at headwaters of the Mississippi River and its tributaries. In charge of the examination and surveys of the sources of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers, with a view to ascertaining the practicability and cost of creating and maintaining reservoirs, &c. Member of Boards of Engineer Officers on proposed bridge across the Mississippi River at Minneapolis, &c., and on bridge over the Ohio River at or near Cairo, Ill.
Charles W. Raymond	In charge of Forts Winthrop, Standish, Andrew, Independence, and work on Long Island Head, and of the construction of Fort Warren, Mass. In charge of the improvement of the harbors at Newburyport, Lynn, Boston (including sea-walls on Point Allerton, Great Brewst

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	Island, Lovell's Island, Long Island Head, Rainsford Island, and Deer Island; Mystic and Charles rivers; and channel leading to Nantasket Beach), Provincetown, Plymouth, and Scituate, Mass. In charge of construction of a national harbor of refuge (of the first class) at Sandy Bay, Cape Ann, Mass. In charge of the improvement of the rivers Merrimac and Malden, Mass. Engineer, temporarily, of 1st and 2d Lighthouse Districts. In charge of Fourth District of the Mississippi River, from Warrenton to Head of the Passes, for the purpose of improvement and the construction and repair of levees, to include levees and special work on the river, the improvement of the harbor at New Orleans, the Mississippi River at Natchez and Vidalia, the mouth of Red River, and the rectification of the Red and Atchafalaya rivers at mouth of Red River. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River.
L. Cooper Overman....	In charge of the improvement of harbors at Port Clinton, Monroe, Toledo, Sandusky, Huron, Vermillion, Black River, Rocky River, Cleveland, Fairport, Conneaut, and Ashtabula, Ohio, and Dunkirk, N. Y. In charge of improvement of Sandusky River, Ohio. In charge of water-level observations on Lake Erie. In charge of the removal of wreck of schooner J. J. Hill, in Fairport Harbor, Ohio.
Alexander M. Miller ...	In charge of the improvement of the rivers Mississippi and Missouri, removal of snags, &c.; Osage River, Mo. and Kans.; Gasconade River, Mo.; Wabash River, Ind. and Ill., and White River, Ind. Member of Board of Engineer Officers on lock and dam at Grand Rapids, Wabash River.
Milton B. Adams	In charge of the construction of Fort Montgomery, N. Y. In charge of the improvement of the harbors at Ogdensburg, on the river Saint Lawrence, and Plattsburg, Burlington, and Swanton, and construction of breakwater at Rouse's Point, on Lake Champlain. In charge of the improvement of Ticonderoga and Grass rivers, N. Y., and Otter Creek, Vt.
Wm. R. Livermore.....	Detached; Engineer Officer, Department of Texas. Member of Commission to run and mark the boundary lines between a portion of the Indian Territory and the State of Texas. Member of general-court-martial to meet at Fort Clark, Tex., August 12, 1885. In charge of the improvement of the Missouri River from its mouth to Sioux City, Iowa.
William H. Heuer	In charge of Forts Taylor and Jefferson, Fla., Jackson, St. Philip, Livingston, Pike, and Macomb, Tower Dupré, Battery Bienvenue, and Tower at Proctorsville, La. In charge of the improvement of the Amite, Tangipahoa, Tickfaw, Tchefuncte, Bogue Falia, and Calcasieu rivers, bayous Terrebonne, Teche, Black, and Courtableau, and Calcasieu Pass, La., Sabine Pass, Blue Buck Bar, and Neches River, Tex., and Sabine River, La. and Tex., and of removal of obstructions in Bayou La Fourche, La. In charge of connecting Bayou Teche with Grand Lake at Charenton, La. To report upon the depth and width of a channel secured and maintained by jetties constructed by

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	James B. Eads at the mouth of the Mississippi River. In charge of removal of wrecks in Mississippi River in front of the wharves at New Orleans, La., and of wreck of steamer John M. Chambers in Bayou Teche. In charge of preliminary examinations of Atchafalaya River above Berwick Bay, and Bayou Pierre, Miss. Engineer 7th and 8th Lighthouse Districts. Member of Board of Engineer Officers on subject of permanent improvement of Delaware River and Bay.
William S. Stanton	Detached; on duty at the Military Academy as instructor of practical military engineering, and in command of Company E, Battalion of Engineers. Member of general court-martial to meet at West Point, N. Y., August 17, 1885. Engineer of 1st and 2d Lighthouse Districts.
Thomas H. Handbury..	Engineer Officer Division of the Missouri. In temporary charge of improvement of the harbors at Chicago and Calumet, Ill. In temporary charge of the improvement of the Illinois and Calumet rivers. In temporary charge of survey of the Hennepin Canal.
CAPTAINS.	
James C. Post	In charge of the improvement of the Little Kanawha, Guyandotte, and Buckhannon rivers, W. Va.; the Big Sandy River, W. Va. and Ky., and the Kentucky and Tradewater rivers, Ky. In charge of preliminary examination and of survey of Rough River, Ky. Member of Board of Engineer Officers on project for improvement of Black Warrior River, Ala.
James F. Gregory	Detached; aid-de-camp on the personal staff of the Lieutenant-General of the Army, with the rank of lieutenant-colonel. Engineer Officer, Headquarters of the Army. On temporary duty in Office of the Chief of Engineers. Detached; Engineer 5th and 6th Lighthouse Districts.
Henry M. Adams	In charge of the 4th and 5th Divisions, Office of the Chief of Engineers.
Charles E. L. B. Davis.	Engineer 10th and 11th Lighthouse Districts. In charge of the improvement of the harbors at Ontonagon, Eagle Harbor, Marquette, Manistique, and Cedar River, Mich.; Menomonee, Green Bay, Ahnepee, Two Rivers, Manitowoc, Sheboygan, Port Washington, Kewaunee, Pensaukee, and Oconto, Wis. In charge of harbors of refuge at entrance to Sturgeon Bay Canal, Lake Michigan, and Grand Marais, Mich. In charge of water-level observations on Lake Superior. Advisory Engineer for improvement of Kewaunee Harbor, Wis.
George M. Wheeler......	On temporary duty to supervise certain publications pertaining to Geographical Surveys West of the 100th Meridian.
James B. Quinn	In charge of the improvement of the Yellowstone River; and the Missouri River from Sioux City, Iowa, to Fort Benton, Mont.
Daniel W. Lockwood ..	In charge of the improvement of the harbors at Charlevoix, Frankfort, Manistee, Ludington, Pentwater, White River, Muskegon, Grand Haven, Black Lake, Saugatuck, South

Statement showing rank and duties of officers of Corps of Engineers—**Cont'd.**

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
	Haven, New Buffalo, and Saint Joseph, and harbor of refuge at Portage Lake, Mich., and harbor at Michigan City, Ind. In charge of the improvement of Grand River from its mouth to city of Grand Rapids, Mich.
Ernest H. Ruffner	In charge of the improvement of the Mississippi River between Des Moines Rapids and the mouth of the Illinois River. To take steps for removal of wreck of steamer A. M. Jarrett, and of flat-boat in Mississippi River at Quincy Bay.
John C. Mallery	Detached; Engineer 4th Lighthouse District.
Clinton B. Sears	In charge of 3d District of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. In charge, temporarily, of 1st and 2d Districts of the Mississippi River.
Thomas Turtle	Detached; secretary and disbursing officer of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member of board of survey to examine into and fix the responsibilty for the loss of certain vessels, &c., used upon the improvement of the Mississippi River. Temporarily secretary and assistant to the construction committee of the Mississippi River Commission, and disbursing officer for works carried on by the Commission.
Edward Maguire	In charge of the construction of Forts Porter, Niagara, and Ontario, N. Y. In charge of the improvement of the harbors at Erie, Pa., and Buffalo, Wilson, Olcott, Oak Orchard, Charlotte, Pultneyville, Great Sodus, Little Sodus, Oswego, and Sackett's Harbor, N. Y. In charge of the improvement of Niagara River, N. Y. In charge of water-level observations on Lake Ontario. Secretary of board of officers and civilians to examine and report at what ports fortifications or other defenses are most urgently required, &c. To locate and map a rock in the Saint Lawrence River six or eight miles below Dark Island.
Frederick A. Mahan	Detached; assistant to the Engineer Commissioner of the District of Columbia.
Charles F. Powell	In charge of Fort Stevens, Oreg., and of the construction of Fort Canby, Wash. In charge of the improvement of the mouth of the Columbia River, Oreg. and Wash., entrance to Coos Bay and entrance to Yaquina Bay, and mouth of Coquille River, Oreg. In charge of the improvement of the Columbia and Lower Willamette rivers below Portland, and Umpqua River, Oreg., and of the rivers Chehalis, Skagit, Stielaquamish, Nootsack, Snohomish, and Snoqualmie, Wash. In charge of water-gauges on the Columbia River from Astoria to the bar. Engineer 13th Lighthouse District. In temporary charge of the improvement of the Columbia River at Cascades, Oreg., Upper Columbia and Snake rivers, Oreg. and Wash., Willamette River above Portland, Oreg., Cowlitz River, Wash., Yamhill River, Oreg., and Lower Clearwater River, Idaho. In temporary charge of survey of Columbia River above mouth of Snake River, Wash. In charge of preliminary examination and of survey of Olympia Harbor, Wash.

tement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
derick A. Hinman	In charge of the improvement of the harbor at Norfolk and the approach to Norfolk Harbor and the United States navy-yard, Va. In charge of the improvement of the Blackwater, Nottoway, Archer's Hope, and Appomattox rivers, Va., Scuppernong, Pamplico, Tar, Yadkin, and Meherrin rivers, Currituck Sound, Coanjok and Edenton Bays, and North River Bar, N. C., and North Landing River, Va. and N. C. Member of board advisory to State harbor commissioners of Norfolk and Portsmouth, Va. To take preliminary steps for removal of wreck of schooner Lawrence from Scuppernong River, N. C. In charge of the removal of wrecks of schooners Tarry Not and Anthea Godfrey, and steamer Concord, on Craney Island Flats, Va., in Lynn Haven Roads, Va., and in Pamplico River, N. C., respectively.
bert H. Payson	In charge of the improvement of Humboldt Harbor and Bay, Cal. In charge of the improvement of the Sacramento, Feather, San Joaquin, and Mokelumne rivers, Cal., and Colorado River, Nev., Cal., and Ariz. Engineer 12th Lighthouse District.
hn G. D. Knight	Commanding Company A, Battalion of Engineers. In charge of the construction of Fort Schuyler, N. Y. H. Member of General Courts-Martial, to meet at Willets Point, N. Y., July 29 and November 2, 1885, and May 3, 1886.
hard L. Hoxie	In charge of Forts Pickens and McRee and the construction of Fort Barrancas and redoubt, Fla. In charge of the improvement of Pensacola Harbor, Fla. In charge of the improvement of the rivers Coosa and Chattahoochee, Ga. and Ala., Ocmulgee, Oconee, Oostenaula, Coosawattee, and Flint, Ga., Choctawhatchee and Conecuh-Escambia, Fla. and Ala., Escambia, Fla., Alabama, Cahawba, and Tallapoosa, Ala., and La Grange Bayou, Fla. In charge of examination or survey of Clear Water Harbor and Upper Oconee River, from Skull Shoals to the Georgia Railroad Bridge. Member of Board of Engineer Officers to consider question of construction of a bridge over the Alabama River at Selma, Ala.
liam L. Marshall	In charge of the improvement of the harbors at Milwaukee, Racine, and Kenosha, Wis., and Waukegan, Ill., and harbor of refuge at Milwaukee Bay, Wis. In charge of the improvement of the rivers Fox and Wisconsin. In charge of water-level observations on Lake Michigan. In temporary charge of the improvement of the harbors at Ontonagon, Eagle Harbor, Marquette, Manistique, and Cedar River, Mich., Menomonee, Green Bay, Ahnapee, Two Rivers, Manitowoc, Sheboygan, Port Washington, Kewaunee, Pensaukee, Oconto, and harbors of refuge at entrance to Sturgeon Bay Canal, Lake Michigan, and Grand Marais, Mich. In temporary charge of water-level observations on Lake Superior. Advisory engineer for improvement of Kewaunee Harbor, Wis.
ph H. Willard	Secretary and assistant to the construction committee of the Mississippi River Commission created by act of Congress approved June 28, 1879, and disbursing officer for works carried on by the Commission. Member of Board of Survey to examine into and fix the responsibility for the

Statement showing rank and duties of officers of Corps of Engineers—Cont'd

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	loss of certain vessels, &c., used upon the improvement of the Mississippi River. In charge of the improvement of Tensas River and Bayou Macon, and Cane River, La., Ouachita and Black River and Bayou Bartholomew in La. and Ark., Bayous Bœuf and D'Arbonne, Loggy Bayou, Lake Bisteneau, and the Dorcheat, La., and Cypress Bayou, La. and Tex.; Red River, La., and South Forked Deer River, Tenn.; of the rivers Big Sun Flower, Yazoo, Yallabusha, Big Black, and Tallahatchie, and Tchula Lake and Steel's Bayou, Miss., and the Big Hatchie River, Tenn. In charge of survey of Bayou Pierre, La. In charge of the water-gauges on the Lower Mississippi River and its principal tributaries.
Philip M. Price	Commanding Company C, Battalion of Engineers. Member of General Court Martial to meet at Willets Point, N. Y., October 12. Detached; on duty at the Military Academy as instructor of Practical Military Engineering, and in command of Company E, Battalion of Engineers. In charge of water-works and supply line, and Acting Signal Officer at West Point, N. Y.
Francis V. Greene	Detached; on duty at the Military Academy as instructor of Practical Military Engineering, and in command of Company E, Battalion of Engineers. Acting Signal Officer at West Point, N. Y. On leave of absence until December 31, 1886.
Carl F. Palfrey	On duty under the immediate orders of Captain Lockwood.
William H. Bixby	In charge of Fort Macon, N. C. In charge of the improvement of Beaufort Harbor, N. C., and Georgetown Harbor, S. C. In charge of the improvement of Cape Fear River above and below Wilmington, Neuse, Trent, and New Rivers, N. C., and Santee, Wateree, Great Pee Dee, and Waccamaw rivers, S. C., and Contentnia or Moccasin River, N. C. In charge of examinations or surveys of Black River, and entrance to Winyaw Bay, near Georgetown, and of survey of Northeast Branch of Cape Fear River. To take necessary steps towards removal of wrecks from Cape Fear River below Wilmington, N. C.
Henry S. Taber	In charge of protection of harbor at Fort Smith, Ark. In charge of the improvement of the Arkansas River, removal of snags, &c.; Arkansas River between Fort Smith, Ark., and Wichita, Kans.; and at Pine Bluff, and of rivers Saint Francis, White, L'Anguille, and Saline, Ark., and Black, Mo. and Ark. In charge of survey of Arkansas River from Fort Gibson to Wichita, Kans., and from Little Rock to its mouth.
Eric Bergland	In charge of the improvement of Tensas and Bayou Macon and Cane Rivers, La.; Ouachita and Black River and Bayou Bartholomew, in La. and Ark.; Bayous Bœuf and D'Arbonne, Loggy Bayou, Lake Bisteneau, and the Dorcheat, La., and Cypress Bayou, La. and Tex.; Red River, La., and South Forked Deer River, Tenn.; of the rivers Big Sun Flower, Coldwater, Yazoo, Yallabusha, Big Black, and Tallahatchie, and Tchula Lake, and Steel's Bayou, Miss., and the Big Hatchie River, Tenn. In charge of survey of Bayou Pierre, La. In charge of the water-gauges on the Lower Mississippi River and its principal tributaries. In charge of examination or survey of Red River from its mouth to Fulton.

Statement showing rank and duties of Officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
William T. Rossell.....	In charge of Forts Marion, Taylor, and Jefferson, Fla. In charge of the improvement of the harbors at Key West, Tampa Bay, and Cedar Keys, Fla. In charge of the improvement of the Saint John's River (at channel over bar at mouth, and upper Saint John's River), Volusia Bar, Caloosahatchee, Manatee, Withlacoochee, Suwannee, and Apalachicola rivers, Apalachicola Bay, and Pease Creek, Fla. In charge of the examination and surveys of Mosquito Inlet, and for canal and inland communication from Saint John's River through Mosquito Lagoon and Indian River to Jupiter Inlet and Lake Worth, Fla. To take preliminary steps toward removal of wreck of steamer Dictator from harbor of Tampa, Fla., and of wreck of scow in Tampa Bay. In charge of 3d District of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss. Member of board of Engineer Officers on building and repair of levees on the Mississippi River.
Thomas N. Bailey......	Commanding Company B, Battalion of Engineers. Member of General Courts-Martial, to meet at Willets Point, N. Y., July 29, October 12, and November 2, 1885, and February 23, 1886.
Thomas W. Symons....	On duty under the immediate orders of Major Lydecker as his assistant in connection with the Washington Aqueduct and the extension thereof. Recorder of Board of Officers on plan of reservoir for additional water-supply for the cities of Washington and Georgetown. Detached; assistant to the Engineer Commissioner of the District of Columbia.
Smith S. Leach........	In charge of 1st District of the Mississippi River, from Cairo to foot of Island No. 40, and 2d District, from foot of Island No. 40 to mouth of White River, for the purpose of improvement and the construction and repair of levees. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River.
Dan C. Kingman.......	Detached; Engineer Officer Department of the Platte. Designated to carry out provisions of act of Congress for improvement of Yellowstone National Park.
FIRST LIEUTENANTS.	
Eugene Griffin........	Detached; on duty at the Military Academy as Assistant Professor of Civil and Military Engineering. Aid-de-camp on the staff of the Major-General commanding Division of the Atlantic. Engineer Officer Division of the Atlantic and Department of the East. Assistant to the Engineer Commissioner of the District of Columbia.
Willard Young.........	On duty under the immediate orders of Major Jones, and temporarily under Captain Powell.
William M. Black......	Detached; on duty at the Military Academy as Assistant Instructor of Practical Military Engineering, and with Company E, Battalion of Engineers. Recruiting Officer of Company E, Battalion of Engineers. Officer in charge of

Statement showing rank and duties of officers of Corps of Engineers—Cont

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	Post Schools. Member of Railroad Board at West Poi N. Y. Member of General Court Martial to meet at We Point, July 1, 1885. On duty under the immediate ord of Captain Rossell. In charge of Fort Marion, Fla. I charge of the improvement of the harbors at Key We Tampa Bay, and Cedar Keys, Fla. In charge of the improvement of the Saint John's River (at channel over b at mouth, and Upper Saint John's River), Volusia B Caloosahatchee, Manatee, Withlacoochee, Suwannee, a Apalachicola rivers, Apalachicola Bay, and Pease Cre Fla. To take preliminary steps toward removal of wre of steamer Dictator from harbor of Tampa, and scow i Tampa Bay, Fla.
Walter L. Fisk	Detached; secretary and disbursing officer of the Misso River Commission. On duty at the Military Academy a Assistant Professor of Civil and Military Engineerin
Solomon W. Roessler...	Adjutant and Treasurer of the Battalion of Engineers a Post of Willets Point, and Signal Officer and Recruiti Officer, Post of Willets Point. Commanding Company I Battalion of Engineers. Inspector of Rifle Practice, Battalion of Engineers. In charge of the library of the Engineer School of Application. To inspect certain unserviceable public property at Fort Schuyler, N. Y. Memb of General Court Martial to meet at Willets Point, N. Y May 3, 1886.
George McC. Derby....	On duty in connection with the removal of obstructions i East River and Hell Gate, N. Y. On duty under the immediate orders of Lieutenant-Colonel McFarland.
James L. Lusk	Quartermaster Battalion of Engineers. Acting Assista Quartermaster and Acting Commissary of Subsistence, Po of Willets Point.
Frederic V. Abbot.....	On duty under the immediate orders of Colonel Gillmore.
Thomas L. Casey	Detached; Engineer Officer Division of the Pacific and Department of California. Inspector of Rifle practice of th Department of California. Member of Commission to ru and mark the boundary lines between a portion of th Indian Territory and the State of Texas.
Theodore A. Bingham..	Detached; Engineer Officer, Department of Arizona. Secretary and disbursing officer of the Missouri River Commission, created by act of Congress approved July 5, 188 Member of Board of Survey to examine into and fix th responsibility for the loss of certain vessels, &c., used upo the improvement of the Mississippi River.
Curtis McD. Townsend.	Detached; Assistant to the Engineer Commissioner of th District of Columbia. On duty with the Battalion of Engineers.
Gustav J. Fiebeger	Detached; on duty at the Military Academy in Department of Civil and Military Engineering. Member of General Court Martial to meet at West Point, N. Y., March 15, 188
Oberlin M. Carter......	On duty under the immediate orders of Colonel Gillmore.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	
George W. Goethals....	On duty under the immediate orders of Lieutenant-Colonel Merrill. Detached; on duty at the Military Academy in Department of Civil and Military Engineering.
John Millis.............	Detached; on duty under the immediate orders of Colonel Duane as his assistant in connection with experiments upon electric lighting.
John Biddle............	Detached; Engineer Officer, Department of Dakota.
Harry F. Hodges	On duty under the immediate orders of Lieutenant-Colonel Poe.
James G. Warren......	On duty under the immediate orders of Major King. Detached; on duty as Assistant Instructor of Pratical Military Engineering at the Military Academy, and with Company E, Battalion of Engineers. Officer in charge of Post Schools, and Recruiting Officer for Company E, Battalion of Engineers. Instructor in Department of Civil and Military Engineering. Member of General Court Martial to meet at West Point, N. Y., March 15, 1886.
Edward Burr..........	On duty under the immediate orders of Captain Powell. Detached; Engineer Officer Department of the Columbia.
Oscar T. Crosby	On duty under the immediate orders of Major Heuer.
Lansing H. Beach	On temporary duty with Company E, Battalion of Engineers. On duty under the immediate orders of Lieutenant-Colonel Merrill. Member and Disbursing Officer of Commission to run and mark the boundary lines between a portion of the Indian Territory and the State of Texas.
Graham D. Fitch	On duty with Company B, Battalion of Engineers. On duty under the immediate orders of Major King, Lieutenant-Colonel Barlow, and Captain Marshall.
Eugene J. Spencer.....	On duty with Company A, Battalion of Engineers. Member of General Court Martial to meet at Willets Point, N. Y., November 2, 1885. Detached; Engineer Officer, Department of Arizona.
George A. Zinn........	On duty with Company B, and temporarily with Company E, Battalion of Engineers. Judge-Advocate of General Court Martial to meet at Willets Point, N. Y., July 29 and October 12, 1885.
William C. Langfitt ...	On duty with Company C, Battalion of Engineers. Member of General Courts Martial to meet at Willets Point, N. Y., July 29, October 12, 1885, and February 23, 1886.
Henry E. Waterman ...	On duty with Company A, Battalion of Engineers. Member of General Court Martial to meet at Willets Point, N. Y., July 29, and Judge-Advocate of General Courts Martial to meet at Willets Point October 12, 1885, February 23 and May 3, 1886.

Statement showing rank and duties of officers of Corps of Engineers—Cont

RANK AND NAME.	DUTIES.
SECOND LIEUTENANTS.	
Irving Hale	On duty with Company C, Battalion of Engineers. Acti Ordnance Officer, Post of Willets Point. Member of Ge eral Courts Martial to meet at Willets Point October and November 2, 1885, and February 23 and May 3, 188
James C. Sanford	On duty with Company A, Battalion of Engineers. Memb of General Courts Martial to meet at Willets Point, Y., October 12, and November 2, 1885. On duty under t immediate orders of Lieutenant-Colonel Houston.
Hiram M. Chittenden	On duty with Company B, Battalion of Engineers. Mem of General Courts Martial to meet at Willets Point, N. July 29, October 12, and November 2, 1885, and Febru 23, 1886, and Judge Advocate of General Court Martial meet May 3, 1886.
Cassius E. Gillette	On duty with Company C, Battalion of Engineers. Mem of General Courts Martial to meet at Willets Point, N. July 29, October 12, and November 2, 1885, and Febru 23 and May 3, 1886.
David DuB. Gaillard	On duty with Company A, Battalion of Engineers. Mem of General Courts Martial to meet at Willets Point, N. July 29, October 12, November 2, 1885, and February and May 3, 1886.
Harry Taylor	On duty with Company B, Battalion of Engineers. Member of General Courts Martial to meet at Willets Point, N. Y., July 29, October 12, November 2, 1885, and February 23, 1886.
William L. Sibert	On duty with Company C, Battalion of Engineers. Member of General Courts Martial to meet at Willets Point, N. Y., July 29, October 12, November 2, 1885, and May 3, 1886.
Joseph E. Kuhn	On duty with Company B, Battalion of Engineers. Member of General Courts Martial to meet at Willets Point, N. Y., October 12, November 2, 1885, and February 23 and May 3, 1886.
William E. Craighill	On duty with Company A, Battalion of Engineers. Member of General Court Martial to meet at Willets Point, N. Y., February 23, 1886.
UNITED STATES AGENTS.	
S. T. Abert	In charge of the improvement of the harbor at Breton Bay, Leonardtown, and at entrance of Saint Jerome Creek, Md. In charge of the improvement of the rivers Rappahannock, Chickahominy, Mattaponi, Totusky, York, Pamunky, and Staunton, Va., Roanoke and French Broad, N. C., and Dan, Va. and N. C.; of channel in Potomac River through flats in front of landing at Mount Vernon, and of Neabsco, Nomini, and Urbana creeks, Va. In charge of preliminary examination and of survey of Colonial Beach, Va.
William F. Smith	In charge of the improvement of the harbors at Wilmington, Del., Annapolis and Cambridge, Md., and ice-harbor at New Castle, Del. In charge of the improvement of the Maurice River, N. J., Broadkiln, Indian, and Saint Jones rivers, Duck, Mispillion, and Broad creeks, Del., Susque-

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
UNITED STATES AGENTS. (continued.)	hanna River, above and below Havre de Grace, and work at the Fishing Battery light-station near Spesutia Island; of the Chester, Wicomico, Choptank, and Elk rivers, Corsica creek, and upper thoroughfare at Deil's Island, Md. In charge of preliminary examinations and of surveys of Tuckahoe Creek and Sassafras River above Georgetown.
UNITED STATES CIVIL ENGINEER.	
M. Meigs..................	On duty under immediate orders of Major Mackenzie.

LAWS

AFFECTING

THE CORPS OF ENGINEERS,

UNITED STATES ARMY,

FORTY-NINTH CONGRESS, FIRST SESSION.

1885-'86.

Declared a lawful structure and post-route.

SEC. 2. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or passengers or freight passing over said bridge, than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States.

Spans.

Proviso.

Draws.

Proviso.

Lights, etc.

Free navigation to be maintained.

Litigation.

SEC. 3. That if said bridge shall be made with unbroken and continuous spans, the spans thereof shall not be less than three hundred feet in length in the clear, and the main span shall be over the main channel of the river. The lowest part of the superstructure of said bridge shall be at least fifty feet above high-water mark, as understood at the point of location, and the bridge shall be at right angles to and its piers parallel with the current of the river: *Provided*, That if the same shall be constructed as a draw-bridge, the draw or pivot pier shall be at or near that shore nearest the channel of the river where, in the opinion of the Secretary of War, the passage through the draw at that point can be consistently maintained; if not so constructed, then the draw-pier to be in the main channel, and the opening or passage-way to be so protected that water-craft can be worked through it by lines when not safe to pass otherwise; and the spans shall not be less than two hundred feet in length in the clear, with two side spans of three hundred feet each, and the piers of said bridge shall be parallel with and the bridge itself at right angles to the current of the river, and the spans shall not be less than ten feet above high-water mark, as understood at the point of location, to the lowest part of the superstructure of said bridge: *Provided also*, That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe. No bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States of the State of Missouri in which any portion of said obstruction or bridge may be located: *Provided further*, That nothing in this act shall be so constructed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt this bridge from the operation of the same.

All railroad companies to have use of bridge; compensation; Secretary of War to decide disagreements.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proofs of the parties.

Plans, etc., for security of navigation, etc., to be submitted to Secretary of War.

SEC. 5. That any bridge authorized to be constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, a topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War.

Assignment of rights of Hannibal and Southwestern Railway Company ratified.

Vol. 22, p. 38

SEC. 6. That all the rights, privileges, and immunities granted and included in an act entitled "An act authorizing the construction of a bridge over the Missouri River at or near Arrow Rock, Missouri," approved April first, eighteen hundred and eighty-two, having been transferred and assigned by the Hannibal and Southwestern Railway Company to its successor, the Central Missouri Railway Company said transfer and assignment is hereby ratified and confirmed to said Central Missouri Railway Company.

Right to amend, etc., reserved.

SEC. 7. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, April 15, 1886.

CHAP. 49.—An act to authorize the Mississippi Water-Power and Boom Company, of Brainard, Minnesota, to construct a dam across the Mississippi River.

April 15, 1886.

Dam across Mississippi River may be built by Mississippi Water-Power and Boom Company, of Brainard, Minn.

Canal and bridge.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of the Government is hereby given to the Mississippi Water-Power and Boom Company of Brainard, Minnesota, to construct across the Mississippi River, at some point not more than two miles from the limits of said city of Brainard, to be approved by the Secretary of War, a dam, canal and the appurtenances thereof, for water-power and other purposes, and in connection therewith a wagon and foot bridge for public travel: *Provided*, That the Government of United States may at any time construct in connection therewith a suitable lock for navigation purposes: *Provided also*, That the Government of the United States may at any time take possession of said dam and control the same for purposes of navigation, by paying said company the actual cost of the same, but shall not do so to the destruction of the water-power created by said dam: *Provided further*, That the Secretary of War may at any time require and enforce, at the expense of the owners, such modification and changes in the construction of said dam as he may deem advisable in the interests of navigation; and that said dam shall, if necessary, be so built that boats and rafts may pass through the same, without the imposition of any toll or charge: *And provided further*, That all suits relative to any obstruction of navigation arising from said dam may be tried in the United States circuit and district courts for Minnesota.

Provisos.

Lock.

Government may take possession.

Navigation.

Litigation.

Right to amend etc., reserved.

SEC. 2. That the right to alter, amend, or repeal this act is hereby expressly reserved without any claim of any kind arising in favor of any party in consequence of such amendment or repeal.

Approved, April 15, 1886.

CHAP. 50.—An act to amend the act of Congress approved June twelfth, eighteen hundred and eighty-four, entitled "An act to authorize the construction of bridges across the Wisconsin, Chippewa, and Saint Croix Rivers, in the State of Wisconsin".

Apr. 22, 1886.

Bridges over Wisconsin, Chippewa, and Saint Croix Rivers, Wis.

Chicago, Burlington and Northern Railroad Company substituted for Winona, Alma and Northern Railway Company.

Vol. 23, ch. 81, p. 41, amended.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That an act of Congress approved June twelfth, eighteen hundred and eighty-four, entitled "An act to authorize the construction of bridges across the Wisconsin, Chippewa, and Saint Croix Rivers, in the State of Wisconsin", be, and the same is hereby, amended by striking out the words "Winona, Alma and Northern Railway Company", wherever the same occur in the said law, and by inserting in lieu thereof the words "the Chicago, Burlington and Northern Railroad Company, its successors and assigns.

Approved, April 22, 1886.

May 1, 1886.

CHAP. 70.—An act authorizing the partition of certain land in Louisville, Kentucky, belonging jointly to John Echols and the Government of the United States.

Partition of land owned by John Echols and the United States, in Louisville, Ky.

Preamble.

Whereas a tract of ground situated in Louisville, Kentucky, adjoining the Louisville and Portland Canal, and known as "Rowan's Basin," is owned by the United States of America and by John Echols in the following proportion and under the following conveyances, to wit: The United States, as the proprietor of the Louisville and Portland Canal and the owner of all the stock of the Louisville and Portland Canal Company, owns an undivided three-eighths of said real estate, by virtue of the following deeds: One from R. H. Campbell and others to the Louisville and Portland Canal Company, recorded in deed-book numbered one hundred and thirty-five, page four hundred and twenty-three, and one from George H. Douglas to said canal company, recorded in deed-book numbered one hundred and thirty-seven, page four hundred and two, both in the Jefferson County, Kentucky, clerk's office; and said John Echols owns an undivided five-eighths of said real estate, under and by virtue of the following deeds to him, to wit: One from Eliza H. Boone and others, recorded in deed-book numbered two hundred and fifty-five, page one hundred and thirty-four; one from Rebecca B. Rowan, trustee, and others, recorded in deed-book numbered two hundred and fifty-four, page three hundred and eighty-two; one from Rowan Buchanan and others, recorded in deed-book numbered two hundred and fifty-four, page three hundred and sixty-two; and one from Samuel J. Broadwell and others, recorded in deed-book numbered two hundred and fifty-four, page six hundred and two, all in the Jefferson County, Kentucky, clerk's office; and it is to the interest of both parties that partition shall be made of said real estate: Therefore,

Secretary of War to agree with Echols as to partition.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War of the United States is hereby authorized and empowered to agree with said Echols, his heirs or his assigns, upon such partition of said real estate as may seem to the Secretary of War to be just and proper, and may, in the name of and on behalf of the United States of America, make, execute, and deliver to said Echols, his heirs or his assigns, and receive from him or them, such deed of conveyance as may effectuate the partition herein provided for.

SEC. 2. That this act shall take effect from its passage.

Approved, May 1, 1886.

May 15, 1886.

CHAP. 329.—An act to authorize the Chicago, Freeport and Saint Paul Railroad Company to construct a bridge across the Saint Croix River (or lake) at any accessible point between Prescott, Wisconsin, and Stillwater, Minnesota.

Chicago, Freeport and St. Paul R. R. Co. authorized to bridge the St. Croix River between Prescott, Wis., and Stillwater, Minn.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Chicago, Freeport and Saint Paul Railroad Company, a corporation duly organized under the laws of the States of Illinois, Wisconsin, and Minnesota, be, and is hereby, authorized to construct and maintain a bridge, and approaches thereto, over the Saint Croix River (a part of which is commonly called Lake Saint Croix"), between the States of Minnesota and Wisconsin, at any accessible point on said river between Prescott, Wisconsin, and Stillwater, Minnesota. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of the corporation by which it may be built, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot-passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Wagon and foot bridge.

Tolls.

Navigation not to be materially interfered with.

SEC. 2. That any bridge built under this act shall be constructed and built without material interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure compliance with these conditions, the corporation, previous to commencing the construction of the bridge, or of the accessory works designed to secure the best practicable channel-way for navigation and confine the flow of the water to a permanent channel at said point, shall submit to the Secretary of War a plan of the bridge and other accessory works provided for in this act, together with a detailed map of the river at

Plans to be submitted to Secretary of War.

the proposed site of the bridge and for a distance of a mile above and below the site, together with all other information touching said bridge and river and accessory works as may be deemed requisite by the Secretary of War to determine whether the said bridge, when built, will conform to the prescribed conditions of this act. That as to any bridge built under this act, if the said bridge shall be made with unbroken and continuous spans, it shall not be of less elevation in any case than fifty feet above extreme high-water mark, as understood at the point of location, to the bottom chord of the bridge, nor shall the spans of said bridge over the main channel be less than two hundred feet in length, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river and not less than two hundred feet in length. That if any bridge built under this act shall be constructed as a drawbridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and the best navigable point, and with draw-openings of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, which said draw shall be opened promptly upon reasonable signal for the passing of boats, vessels, and other water-craft; and the spans adjoining said draw shall not be less than two hundred feet wide in the clear, and the elevation of the bottom chord of said bridge shall not be less than ten feet above the extreme high-water mark: *Provided, however*, That no bridge shall be built under the provisions of this act except there also be built, at the time of the erection of the piers, proper sheer-booms or other proper protections to safely guide boats, vessels, rafts, and other water-craft through said draw-spans, and at the expense of the company or corporation erecting the bridge; and said company or corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Secretary of War shall prescribe.

Spans.

Draw.

Proviso.

Protection to navigation; lights, etc.

Approval of Secretary of War.

SEC. 3. That the Secretary of War is hereby authorized and directed, upon receiving any such plan and map and other information, and upon being satisfied that a bridge built on such plan and with such accessory works and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; but until the Secretary of War approve the plan and location of said bridge and other accessory works provided for in this act, and notify the company of the same, the bridge shall not be built; and should any change be made in the plan of the bridge or other accessory works provided for in this act, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War, not, however, to be in any wise inconsistent with the provisions or conditions of this act.

Bridge declared a lawful structure and post-route.

SEC. 4. That any bridge and accessory works, when built and constructed under this act and according to its provisions and conditions, shall be a lawful structure; and said bridge shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post-routes in the United States; and Congress reserves the right at any time to regulate, by appropriate legislation, the charges for freight and passengers over said bridge; and the United States shall have the right of way for postal-telegraph and telegraph lines, free of charge, across said bridge.

Charges.

Postal telegraph.

Aids to navigation, if necessary, to be provided.

SEC. 5. That it shall be the duty of the Secretary of War, on satisfactory proof that a necessity exists therefor, to require the company or persons owning said bridge to cause such aids to the passage of said bridge authorized by the provisions of this act to be constructed, placed, and maintained, at their own cost and expense, in the form of booms, dikes, piers, or other suitable and proper structures for confining the flow of water to a permanent channel, and for the guiding of rafts, steamboats, and other water-craft safely through the draw and raft spans, as shall be specified in his order in that behalf; and on the failure of the company or persons aforesaid to make and establish such additional structures within a reasonable time, the said Secretary shall

Attorney-General to bring suit in case of failure.

proceed to cause the same to be built or made at the expense of the United States, and shall refer the matter, without delay, to the Attorney-General of the United States, whose duty it shall be to institute, in the name of the United States, proceedings in any circuit court of the United States in which such bridge, or any part thereof, is located, for the recovery of the cost thereof; and all moneys accruing from such proceedings shall be covered into the Treasury of the United States.

Right to amend, etc., reserved.

SEC. 6. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structure, at the expense of the owners thereof, whenever Congress shall decide that the public interests require it, is also expressly reserved.

SEC. 7. That this act shall take effect and be in force from and after its passage.

Approved, May 15, 1886.

May 15, 1886.

CHAP. 330. An act authorizing the construction of a bridge across the Mississippi River at or near Keithsburg, in the State of Illinois, and for other purposes.

New York and Council Bluffs Railway Company authorized to bridge the Mississippi River at Keithsburg, Ill.

Free navigation not to be interfered with.

Litigation.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the assent of Congress is hereby given to the New York and Council Bluffs Railway Company, a corporation duly created and organized under the laws of the States of Ohio, Indiana, Illinois, and Iowa, or its successors or assigns, to build a bridge across the Mississippi River at such point on said river at or near Keithsburg, in the State of Illinois, as may accommodate lines of railroad which said corporation may build to said point on the said Mississippi River, or to a point on the west bank of said river in the State of Iowa, opposite to said point at or near Keithsburg, in the State of Illinois, and to lay on or over said bridge a railroad track or tracks, for the more perfect connection of any railroad or railroads that are or shall be constructed to said river, on either or both sides thereof, at or opposite said point, under the limitations and conditions hereinafter provided; that said bridge shall not interfere with the free navigation of said river beyond what is necessary in order to carry into effect the rights and privileges hereby granted; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, the cause may be tried before the circuit court of the United States in and for any district in which any portion of said bridge or obstruction touches.

May be either draw-bridge or unbroken span.

Provisos.

Height and spans if not a draw-bridge.

Draw.

Spans.

SEC. 2. That any bridge built under the provisions of this act may, at the option of the company building the same, be built as a draw-bridge or with unbroken and continuous spans: *Provided*, That if the said bridge shall be made with unbroken and continuous spans, it shall not be of less elevation in any case than fifty-feet above extreme high-water mark, as understood at the point of location, to the bottom chord of the bridge, nor shall the spans of said bridge give a clear width of water-way of less than two hundred and fifty feet, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river and give a clear width of water-way of not less than three hundred feet: *And provided further*, That if any bridge built under the provisions of this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans giving a clear width of water-way of not less than one hundred and sixty feet on each side of the central or pivot pier of the draw; and the next adjoining span or spans to the draw shall give a clear width of water-way of not less than two hundred and fifty feet, and said spans shall not be less than thirty feet above low-water mark, measuring to the bottom chord of the bridge, and the piers of said bridge shall be parallel with the current of the river where said bridge shall be erected: *And provided also*, That said draw shall be opened promptly upon reasonable signal for the passage of boats.

To be a lawful structure and post-route.

SEC. 3. That any bridge constructed under this act and according to its limitations shall be a lawful structure, and shall be known as a post-route, and the same is hereby declared to be a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or for passengers or freight passing over said bridge, than the rate per mile paid for their transportation over the railroads and public highways leading to said bridge; and the United States shall have the right of way for postal-telegraph purposes across said bridge.

Postal telegraph.

Other railway companies may use the bridge, upon terms to be prescribed by Secretary of War.

SEC. 4. That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree.

Plans, etc., to be subject to approval of Secretary of War.

SEC. 5. That the structure herein authorized shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, and the direction and strength of the current at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as shall be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge, during the progress of construction, such change shall be subject to the approval of the Secretary of War; and the said structure shall be at all times so kept and managed as to offer reasonable and proper means for the passage of vessels through or under said structure; and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights as may be prescribed by the Secretary of War. And the said structure shall be changed or removed, at the cost and expense of the owners thereof, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to revocation and modification by law when the public good shall, in the judgment of Congress, so require, without any expense or charge to the United States.

Lights.

Right to amend etc., reserved.

SEC. 6. That the right to alter, amend, or repeal of this act is hereby expressly reserved.

SEC. 7. That this act shall take effect and be in force from and after its passage.

Approved, May 15, 1886.

May 15, 1886.

CHAP. 331.—An act authorizing the construction of bridges across the Illinois River, in the State of Illinois, and the Des Moines River, in the State of Iowa, and for other purposes.

New York and Council Bluffs Railway Company authorized to bridge the Illinois River at Lacon, Ill., and Des Moines River, Iowa.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the assent of Congress is hereby given to the New York and Council Bluffs Railway Company, an organization incorporated under the laws of the States of Ohio, Indiana, Illinois, and Iowa, its successors or assigns, to construct bridges over the Illinois River at or near the town of Lacon, in the State of Illinois, and over the Des Moines River, in the State of Iowa, and in such county of said State of Iowa as said railway company may desire or find most practicable in the final location of its road.

May be draw, span, or otherwise, not obstructing navigation.

SEC. 2. That said bridges shall be so constructed, either by draw, span, or otherwise, that a free and unobstructed passage may be secured to all vessels and other water-craft navigating said rivers.

To be lawful structures and post-routes.

SEC. 3. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or passengers or freight passing over said bridges, than the rate per mile paid for the transportation over the railroads or public highways leading to said bridges; and they shall enjoy the rights and privileges of other post-roads of the United States.

Draws, lights, etc.

SEC. 4. That if either of said bridges authorized to be constructed by this act shall be constructed as a draw-bridge, the draw shall be opened promptly upon reasonable signals for the passage of boats; and said company or corporation shall maintain, at its own expense, from sunset until sunrise, such lights or other signals on said bridge or bridges as the Secretary of War shall prescribe. No bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said rivers; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such obstructions shall be removed and alterations made at the expense of the owner or owners of said bridge: *Provided*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt any bridge erected under this act from the operations of the same.

Proviso.

No repeal or modification of laws protecting navigation.

Other companies entitled to use upon terms to be determined by Secretary of War.

SEC. 5. That all railroad companies desiring the use of either of said bridges that may be erected under the provisions of this act shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same, and over the approaches thereto, upon the payment of a reasonable compensation therefor; and in case the owner or owners of said bridge or bridges, and the several railroad companies, or any one of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge or bridges, all matters of issue between them shall be decided by the Secretary of War, upon the hearing of the allegations and proofs of the parties.

Plans, etc., to be subject to approval of Secretary of War.

SEC. 6. That any bridge authorized to be constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said rivers as the Secretary of War shall prescribe; and to secure that object said company or corporation shall submit to the Secretary of War, a design and drawings of said bridge or bridges to be erected, for his examination and approval, and a map of its location, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and in all things shall be subject to such rules and regulations as may be prescribed by the Secretary of War; and until said plan and location of said bridge or bridges are approved by the Secretary of War said bridge or bridges shall not be built; and should any change be made in the plan of any such bridge or bridges authorized to be constructed under this act, during the progress of the work of construction, such change shall be subject to the approval of the Secretary of War.

Right to amend, etc., reserved.

SEC. 7. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structures, or their removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

SEC. 8. That this act shall take effect and be in force from and after its passage.

Approved, May 15, 1886.

May 15, 1886.

CHAP. 332.—An act to authorize the Red River Bridge Company of Texas to maintain a bridge across Red River.

Red River Bridge Company of Texas, authorized to build a railway and wagon bridge across the Red River near Denison, Tex.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Red River Bridge Company of Texas, composed of Frank Colbert, W. B. Munson, J. B. McDougal, J. R. Carr, Samuel Star, J. T. Munson, Edward Perry, and L. L. Maughs, be and is hereby, authorized to construct and maintain a railway and wagon bridge across Red River between the State of Texas and the Chickasaw Nation of the Indian Territory, at any accessible point on said river near Denison, Texas, that may be selected by said company; and said company shall be permitted to charge and take such rates of toll for crossing said bridge as may be reasonable, subject to the approval of the Secretary of War; the said bridge to be of such height as not to interfere with the navigation of said river: *Provided*, That any bridge constructed under this act and according to its limitations

Tolls.

Height.

Provisos.

shall be a lawful structure, and shall be known and recognized as a post-route, and the same is hereby declared to be a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or for through passengers or freight passing over said bridge, than the rate per mile paid for their transportation over the railroads leading to the said bridge; and the United States shall have the right of way for a postal telegraph across said bridge: *And provided further*, That before this act shall take effect said company shall submit to the Secretary of War the plans of said bridge, showing the existing structure and any additions or changes that may be contemplated; and that it shall be decided by the said Secretary that the bridge does not and will not obstruct, impair, or injuriously modify the navigation of the said river, due regard being had to the character of the proposed navigation of said stream.

To be a lawful structure and post-route.

Postal telegraph.

Plans subject to approval of Secretary of War

SEC. 2. That Congress reserves the right to alter, amend, or repeal this act at any time; and that if at any time navigation of the said river shall in any manner be obstructed or impaired by the said bridge, the Secretary of War shall have authority, and it shall be his duty, to require the said company to alter and change the said bridge, at its own expense, in such manner as may be proper to secure free and complete navigation without impediment; and if upon reasonable notice to said company to make such change or improvements the said company fails to do so, the Secretary of War shall have authority to make the same at the expense of said company, and all the rights conferred by this act shall be forfeited; and Congress shall have power to do any and all things necessary to secure the free navigation of the river.

Free navigation to be preserved.

Approved, May 15, 1886.

CHAP. 234.—An act to authorize the construction of a railroad and wagon bridge across the Mississippi River from Winona, Minnesota, to the opposite shore in Wisconsin.

May 15, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Winona Pontoon Bridge Company, a corporation existing under the laws of the State of Minnesota, is hereby authorized to construct and maintain a pile and pontoon railway and wagon bridge across the Mississippi River from the city of Winona, State of Minnesota, so as to connect with the opposite shore of said river, in the State of Wisconsin, said bridge to be built subject, except as herein modified to all the terms, requirements and limitations contained in the act entitled "An act to legalize and establish a pontoon railway bridge across the Mississippi River at Prairie du Chien, and to authorize the construction of a similar bridge at or near Clinton, Iowa," approved June sixth, eighteen hundred and seventy-four, so far as they may be applicable thereto.

Winona Pontoon Bridge Company, authorized to bridge the Mississippi River at Winona, Minn.

Subject to terms of vol. 18, ch. 224, p. 62.

SEC. 2. That said bridge shall be so constructed with a suitable pontoon draw of not less than four hundred feet in width, located over the main channel of the river: *Provided*, That said bridge shall not be built or commenced until the plan and specifications for its construction have been submitted to the Secretary of War for his approval, nor until he shall approve the plan and location of said bridge; and if any change be made in the plan of construction of said bridge at any time, such change shall be subject to the approval of the Secretary of War; and any change in the construction or any alteration of said bridge that may be directed at any time by Congress or the Secretary of War shall be made at the cost and expense of the owners thereof.

Draw.

Proviso.

Subject to approval of Secretary of War as to plans, etc.

SEC. 3. That if said bridge is constructed as a wagon bridge, the said company may charge such reasonable rates of toll for the passage of wagons and vehicles of all kinds and for the transit of animals and foot-passengers thereon as may from time to time be approved by the Secretary of War.

Tolls.

SEC. 4. That Congress may at any time alter, amend, or repeal this act.

Approved, May 15, 1886.

May 15, 1886.

CHAP. 335.—An act to authorize the construction of a bridge across the Yellowstone River, in Montana.

Miles City Bridge Company authorized to bridge the Yellowstone River at Miles City, Montana.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Miles City Bridge Company, a corporation existing under the laws of the Territory of Montana, and having authority to construct and maintain a bridge across the Yellowstone River at or near Miles City, in the county of Custer, in said Territory, be, and is hereby, authorized to construct and maintain, for the purpose of making a more perfect crossing of said river at all times during the year, a bridge across the said Yellowstone River at or near said Miles City, to be used by said company, its successors or assigns, for all purposes of rail and other transportation over said river.

Not to impair free navigation.

Plans, etc., subject to approval of Secretary of War.

Provisos. Spans.

Draw.

Lights, etc.

Other companies to have right of way.

SEC. 2. That any bridge built under this act shall be constructed and built without material interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure a compliance with these conditions the corporation, previous to commencing the construction of the bridge, or of the necessary works in the booms, dikes, or piers designed to secure the best practicable channel-way for navigation and confine the flow of water to a permanent channel, and for the guiding of steamboats and rafts safely through the draw-spans at said point, shall submit to the Secretary of War a plan of the bridge and of such accessory works, together with a detailed map of the river at the proposed site of the bridge and for a distance of a mile below and above the site, together with all other information touching said bridge and river and accessory works as may be deemed requisite by the Secretary of War to determine whether the said bridge, when built, will conform to the prescribed conditions of this act; that, as nearly as practicable, the said bridge shall be at right angles to and the piers parallel with the current of said river; and if it be found hereafter that the said bridge or accessory works materially interfere with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted, by reason of any defect or failure in the accessory works aforesaid to accomplish the purpose for which they are designed, it shall be the duty of the Secretary of War to require the necessary changes to be made therein, in the interest of navigation, at the expense of the owners: *Provided*, That as to any bridge built under this act, if the said bridge shall be built of unbroken and continuous spans, it shall not be of less elevation in any case than fifty feet above extreme high-water mark, as understood at the point of location, to the bottom chord of the bridge, nor shall the spans of said bridge be less than two hundred feet in length, and the main spans shall be over the main channel of the river and not less than two hundred feet in length: *And provided also*, That if any bridge built under the provisions of this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans not less than ten feet above extreme high-water mark at the point of location, and of not less length than one hundred feet on each side of the central or pivot pier of the draw; and the next adjoining spans shall be not less than one hundred and twenty-five feet in length, unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction: *Provided also*, That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board may prescribe: *Provided also*, That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and the fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree.

Secretary of War to give his approval before bridge can be commenced.

SEC. 3. That the Secretary of War is hereby authorized and directed, upon receiving any such plans and map and other information, and upon being satisfied that a bridge built upon such plan and with such accessory works and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same;

and upon receiving such notification the said company may proceed to an erecting of said bridge, conforming strictly to the approved plan and location; but until the Secretary of War approve the plan and location of said bridge and accessory works, and notify the company of the same, the bridge shall not be commenced; and should any change be made in the plan of the bridge or accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War.

SEC. 4. That any bridge and accessory works, when built and constructed under this act and according to the terms and limitations thereof, shall be a lawful structure; and said bridge shall be recognized and known as a post-route, and said bridge shall enjoy the rights and privileges of other post-routes in the United States; and Congress reserves the right to regulate by appropriate legislation the charges for freight and passengers over said bridge.

To be a lawful structure and post-route.

Charges may be regulated by Congress.

SEC. 5. That the United States shall have the right of way for postal telegraph across said bridge.

Postal telegraph.

SEC. 6. That the said Miles City Bridge Company, its successors and assigns, shall have the right to charge tolls for the use of said bridge, except as hereinbefore limited and provided.

Tolls.

SEC. 7. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interests require it, is also expressly reserved.

Right to amend, etc., reserved.

Approved, May 15, 1886.

CHAP. 342.—An act authorizing the removal of the statue of Major-General John A. Rawlins from its present location to a site to be selected by the Secretary of War.

May 17, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to have the statue of Major-General John A. Rawlins removed from the present location to another site within the limits of the city of Washington, District of Columbia, to be selected by the Secretary of War; and an amount not exceeding five hundred dollars is hereby appropriated for that purpose out of any money in the Treasury not otherwise appropriated.

Statue of Major-General John A. Rawlins to be removed to another site.

Appropriation

Approved, May 17, 1886.

CHAP. 344.—An act to authorize the construction of a bridge across the Missouri River at some accessible point within ten miles below and five miles above the city of Kansas City, Missouri.

May 17, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Wabash, Saint Louis and Pacific Railway, a corporation duly organized, be, and is hereby, authorized to construct and maintain a bridge, and approaches thereto, over the Missouri River, at some accessible point consistent with the interests of the river navigation within five miles above and ten miles below the present railroad bridge across said river at the city of Kansas City, in the county of Jackson and State of Missouri. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of the corporation by which it may be built, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot-passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Wabash, Saint Louis and Pacific Railway authorized to bridge the Missouri River, near Kansas City, Mo.

Wagon and foot bridge.

Tolls.

SEC. 2. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or for passengers and freight passing over said bridge, than the rate per mile paid for the transportation over the railroad or public highways leading to said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States.

To be a lawful structure and post-route.

Spans.

Provisos.
Draws.

Lights, etc.

Free navigation not to be obstructed.

Litigation.

SEC. 3. That if said bridge shall be made with unbroken and continuous spans, the spans thereof shall not be less than three hundred feet in length in the clear, and the main span shall be over the main channel of the river. The lowest part of the superstructure of said bridge shall be at least fifty feet above extreme high-water mark, as understood at the point of location, and at least eighty feet above low water, and the bridge shall be at right angles to and its piers parallel with the current of the river: *Provided*, That if the same shall be constructed as a draw-bridge, it shall have two or more pivot or draw-span openings over the main channel of the river, giving one hundred and sixty feet clear channel-way in each opening, and the piers of said bridge shall be parallel with and the bridge itself at right angles to the current of the river; also that all fixed spans located between the shore-lines at the medium stage of water shall be three hundred feet or more in length, and that the clear head-room under such spans shall not be less than ten feet at highest water: *Provided also*, That said draw shall be opened promptly, upon reasonable signal, for the passage of boats; and said corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe. No bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstructions; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States of the State of Missouri in which any portion of said obstruction or bridge may be located: *Provided further*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt this bridge from the operation of the same.

Other companies to have right of way.

Secretary of War to decide disagreement as to compensation.

Proviso.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proofs of the parties: *Provided*, That the provisions of section two in regard to charges for passengers and freight across said bridge shall not govern the Secretary of War in determining any question arising as to the sum or sums to be paid to the owners of said bridge by said companies for the use of said bridge.

Plans, &c., subject to approval of Secretary of War.

SEC. 5. That any bridge authorized to be constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said persons or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War.

Right to amend, etc.

SEC. 6. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

Approved, May 17, 1886.

CHAP. 345.—An act to give the assent of Congress to the construction of a bridge by the Nashville, Jackson and Memphis Railroad Company over the Tennessee River.

May 17, 1886.

Nashville, Jackson and Memphis Railroad Company authorized to bridge the Tennessee River, in Tennessee.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the assent of Congress is hereby given to the Nashville, Jackson and Memphis Railroad Company, a corporation organized under the laws of the State of Tennessee, to construct and maintain a bridge, and approaches thereto, over the Tennessee River, at a point in the counties of Perry and Decatur, in said State of Tennessee, where it is most practicable (to be determined by actual survey) for said railroad to cross said river. Said bridge shall be constructed to provide for the passage of the locomotives, passenger and freight trains, and other rolling-stock of said Nashville, Jackson and Memphis Railroad Company over the same.

To be a lawful structure and post-route.

Proviso.

Postal telegraph.

SEC. 2. That any bridge built under the provisions of this act and subject to its limitations shall be a lawful structure, and recognized and known as a post-route; and it shall enjoy the rights and privileges of other post-roads in the United States: *Provided*, That the United States may construct a postal telegraph over said bridge without charge therefor.

Spans.

Provisos.

Dimensions.

Draw.

Dimensions.

Protections to navigation.

Lights.

Free navigation not to be obstructed.

Litigation.

SEC. 3. That if said bridge shall be built with unbroken and continuous spans, the spans thereof shall be of such width and height above the water as may be prescribed by the Secretary of War: *Provided*, That the same shall not be less than one hundred and sixty-four feet each in the clear; and the main span shall be over the main channel of the river, and the bridge shall be at right angles to and its piers parallel with the current of the river: *Provided*, That if the same shall be constructed as a draw-bridge, the draw or pivot span shall be over the main channel at an accessible point, and the span shall be of such width and height above the water as may be prescribed by the Secretary of War: *Provided*, that said draw or pivot spans shall not be less than one hundred and sixty-four feet in the clear on each side of the draw or pivot pier; and the piers of said bridge shall be parallel with and the bridge itself at right angles to the current of the river: *Provided also*, That the said draw shall be opened promptly by said corporation upon reasonable signal for the passage of boats; that sheer-booms shall be constructed by said corporation; and that said corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light House Board shall prescribe. No bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of such bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of said corporation; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the circuit court of the United States in whose jurisdiction any portion of said obstruction or bridge may be located: *Provided further*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt the bridge herein authorized to be constructed from the operations of the same.

Plans, etc., subject to approval of Secretary of War.

SEC. 4. That any bridge authorized to be constructed under the provisions of this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for a space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War.

Right to amend, etc., reserved.

SEC. 5. That the right to alter, amend, or repeal this act is hereby expressly reserved, and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

Approved May 17, 1886.

May 17, 1886.

CHAP. 347.—An act authorizing the construction of a bridge across the Missouri River at or near the city of Council Bluffs, Iowa, and for other purposes.

New York and Council Bluffs Railway Company authorized to bridge the Missouri River in Iowa.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the New York and Council Bluffs Railway Company, an incorporation organized under the laws of the States of Ohio, Indiana, Illinois, and Iowa, its successors or assigns, is hereby authorized to construct and maintain a bridge across the Missouri River at such point as may be hereafter selected by said corporation, between the north and south lines of the county of Pottawattamie, in the State of Iowa, and at least one-third of a mile from any other bridge, as shall best promote the public convenience and welfare and the necessities of business and commerce, and also to construct and maintain the accessory works necessary to secure the best practicable channel-way for navigation and to confine the flow of the water to a permanent channel at such point, and also, if the said corporation shall deem it for the best interests of the public so to do, to lay on and over said bridge a railway track, for the more perfect connection of any railroads that are or shall be constructed to said river at or opposite to said point; and said corporation shall construct and maintain ways for wagons, carriages, and for foot-passengers, and may charge and receive such reasonable toll therefor as may be approved from time to time by the Secretary of War: *Provided,* That said bridge, and all the property belonging thereto or connected therewith, may be constructed, maintained, and used as a combined railway and wagon bridge, for the safe and convenient passage of wagons, carriages, stock, steam, cable, and street cars, foot-passengers, and all road travel, or as a wagon-bridge alone, for the safe and convenient passage of wagons, carriages, stock, and foot-passengers, as the said corporation shall elect, as hereinbefore provided; but if the said corporation shall elect to build a combined railroad and wagon bridge, then the track for wagons, carriages, stock, and foot-passengers shall not be upon the same space as that used for railroad track and cars.

Wagon and foot bridge.

Tolls.

Proviso.

Combined railroad and wagon bridge.

Free navigation not to be obstructed.

SEC. 2. That said bridge shall be constructed and built without material interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built: *Provided,* That if the said bridge shall be made with unbroken and continuous spans, it shall have three or more channel-spans, and shall not be of less elevation in any case than fifty feet above extreme high-water mark, as understood at the point of location, to the bottom chord of the bridge, nor shall the spans of said bridge be less

Plans, etc., subject to approval of Secretary of War.

Provisos.

Spans.

than three hundred feet in length, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the said river and not less than three hundred feet in length: *And provided also*, That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head-room under such span shall not be less than ten feet above high-water mark: *And provided also*, That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset until sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe: *And provided also*, That if said company or corporation shall elect, as is hereinbefore provided, to erect a combined railroad and wagon bridge, then all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties in case they shall not agree.

Draw.

Lights, etc.

Other companies to have right of way.

Secretary of War to decide disagreement as to terms.

SEC. 3. That the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and upon being satisfied that a bridge built on such plan, and with such accessory works, and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or said accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river caused or alleged to be caused by said bridge, the case may be brought in the circuit court of the United States for the State of Iowa or the State of Nebraska, in which any portion of said obstruction or bridge may be located.

Secretary of War to notify company of approval.

Litigation.

SEC. 4. That the said bridge and accessory works, when built and constructed under this act and according to the terms and limitations thereof, shall be lawful structures; and said bridge shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post-routes of the United States; and Congress reserves the right any time to regulate by appropriate legislation the charges for freight and passengers over said bridge.

To be a lawful structure and post-route.

Charges.

SEC. 5. That the United States shall have the right of way for such postal-telegraph lines across said bridge as the Government of the United States may construct and control.

Postal telegraph.

SEC. 6. That Congress shall have power at any time to alter, amend, or repeal this act so as to prevent or remove all material and substantial obstructions to the navigation of said river by the construction of said bridge and its accessory works; and the expense of altering said bridge or removing such obstructions shall be at the expense of the owners of or persons controlling said bridge.

Right to amend, etc., reserved.

SEC. 7. That this act shall take effect and be in force from and after its passage.

Approved, May 17, 1886.

May 17, 1886.

CHAP. 348.—An act authorizing the Inter-State Rapid Transit Railway Company to build a bridge across the Kansas River.

Inter-State Rapid-Transit Railway Company authorized to bridge the Kansas River, between Wyandotte and Kansas, Kans.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Inter-State Rapid-Transit Railway Company, a corporation duly and legally organized and existing under and by virtue of the laws of the State of Kansas, its successors or assigns, be, and is hereby, authorized to construct and maintain a bridge, and approaches thereto, over the Kansas River, in Wyandotte County, in the State of Kansas, between the city of Wyandotte and the city of Kansas, Kansas, at the point where said company's line of railway, as now projected, crosses said river, near the mouth thereof. Said bridge shall be constructed to provide for the passage of its railway trains, and, at the option of said company by which it may be built, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Wagon and foot bridge.

Tolls.

Post-route.

SEC. 2. That the bridge that shall be built under this act shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States.

Free navigation not to be obstructed.

Secretary of War to prevent.

SEC. 3. That no bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the circuit court of the United States in and for the district of Kansas: *Provided,* That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt said bridge from the operation of the same.

Litigation.

Proviso.

Right to amend, etc., reserved.

SEC. 4. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, May 17, 1886.

May 17, 1886.

CHAP. 350.—An act to authorize the construction of a bridge across the Missouri River at a point to be selected either in the counties of Clay and Jackson, in the State of Missouri, or in the county of Clay or Platte, in said State, and the county of Wyandotte, in the state of Kansas, and to make the same a post-route.

Chicago, Milwaukee and Saint Paul Railway Company authorized to bridge the Missouri River, in Missouri and Kansas.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Chicago, Milwaukee and Saint Paul Railway Company, a corporation organized under the laws of the State of Wisconsin, and authorized by the laws of the State of Missouri to locate and construct its railway into and through said State, is hereby authorized to construct and maintain a bridge across the Missouri River, on such line as its railway may hereafter be located, either in the counties of Clay or Jackson, in the State of Missouri, or in the county of Clay or Platte, in said State, and the county of Wyandotte, in the State of Kansas; and also to construct accessory works to secure the best practicable channel-way for navigation and confine the flow of the water to a permanent channel at such point; and also to lay on and over such bridge a railway track for the more perfect connection of its railway when constructed to said river.

Free navigation not to be obstructed.

SEC. 2. That said bridge shall be constructed and built without material interference with the security and convenience of the navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the

Plans, etc., to be approved by the Secretary of War.

Provisos.

Spans.

Draw.

Lights, etc.

said company or corporation shall submit to the Secretary of War, for his examination and approval, a plan, design, and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built: *Provided,* That if the said bridge shall be made with unbroken and continuous spans, it shall have three or more channel-spans of not less than three hundred feet each in the clear, and shall not be of less elevation in any case than fifty feet above extreme high-water mark as understood at the point of location, to the bottom chord of the bridge, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river, and not less than three hundred feet in length in the clear: *Provided also,* That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with the draw over the main channel of the river at an accessible and navigable point, and with spans of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head-room under such span shall not be less than ten feet above high-water mark: *Provided also,* That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with the draw over the main channel of the river at an accessible and navigable point, and with spans of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head-room under such span shall not be less than ten feet above high-water mark: *Provided also,* That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridges as the Light-House Board shall prescribe.

Secretary of War to notify company of approval.

Litigation.

SEC. 3. That the Secretary of War is authorized and directed, upon receiving such plan, map, and other information, and upon being satisfied that the bridge built upon such plan and with such accessory works and at such locality will conform to the prescribed conditions of this act, to notify said company or corporation that he approves the same; and upon receiving such notification said company or corporation may proceed to the erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or said accessory works during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river caused or alleged to be caused by said bridge, the case may be brought in the circuit court of the United States of the district where said bridge or any part thereof is located.

To be a lawful structure and post-route.

SEC. 4. That the said bridge and accessory works, when built and constructed under this act and according to the terms and limitations thereof, shall be lawful structures; and said bridge shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or for passengers and freight passing over said bridge, than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post-routes in the United States.

Postal telegraph.

SEC. 5. That the United States shall have the right of way for such postal-telegraph lines across said bridge as the Government may construct or control.

Other companies to have right of way.

SEC. 6. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and

Secretary of War to decide disagreements as to terms.

Proviso.
Charges.

in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proofs of the parties: *Provided*, That the provisions of section four in regard to charges for passengers and freight across said bridge shall not govern the Secretary of War in determining any question arising as to the sum or sums to be paid to the owners of said bridge by said companies for the use of said bridge.

Right to amend, etc., reserved.

SEC. 7. That Congress shall have power at any time to alter or amend this act so as to prevent or remove all material and substantial obstructions to the navigation of said river by the construction of said bridge and its accessory works; and the expense of altering said bridge or removing such obstructions shall be borne by the owners of or persons controlling such bridge.

Approved, May 17, 1886.

May 17, 1886.

CHAP. 351.—An act to authorize the construction of a pile and pontoon railway and wagon bridge across the Mississippi River from the city of Red Wing, Minnesota to the opposite shore, in the State of Wisconsin.

Red Wing Pontoon Bridge Company authorized to bridge the Mississippi River, at Red Wing, Minn.
Subject to terms of Vol. 18, ch. 224, p. 62.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Red Wing Pontoon Bridge Company, a corporation existing under the laws of the State of Minnesota, is hereby authorized to construct and maintain a pile and pontoon railway and wagon bridge across the Mississippi River, from the city of Red Wing, State of Minnesota, so as to connect with the opposite shore of said river, in the State of Wisconsin; said bridge to built subject, except as herein provided, to all the terms, requirements, and limitations contained in the act entitled "An act to legalize and establish a pontoon railway bridge across the Mississippi River at Prairie du Chien, and to authorize the construction of a similar bridge at or near Clinton, Iowa", approved June sixth, eighteen hundred and seventy-four, so far as they may be applicable thereto.

Draw.

Proviso.
Subject to approval of Secretary of War, as to plans, etc.

SEC. 2. That said bridge shall be so constructed with a suitable pontoon draw of not less than four hundred feet in length, located over the main channel of the river: *Provided*, That said bridge shall not be built or commenced until the plan and specifications for its construction have been submitted to the Secretary of War for his approval, nor until he shall approve the plan and location of said bridge; and if any change be made in the plan of construction of said bridge at any time, such change shall be subject to the approval of the Secretary of War; and any change in the construction or any alteration of said bridge that may be directed at any time by Congress or the Secretary of War shall be made at the cost and expense of the owners thereof.

Tolls.

SEC. 3. That if said bridge is constructed as a wagon bridge, the said company may charge such reasonable rates of toll for the passage of wagons and vehicles of all kinds and for the transit of animals and foot-passengers as may from time to time be approved by the Secretary of War.

SEC. 4. That Congress may at any time alter, amend, or repeal this act.

Approved, May 17, 1886.

May 17, 1886.

CHAP. 352.—An act to authorize the construction of a bridge over the Missouri River at the most accessible point between the mouth of the Femme Osage Creek and a point two miles above the city of Saint Charles, in the county of Saint Charles in the State of Missouri.

Saint Louis Kansas City Short-Line Railway Company authorized to bridge the Missouri River, near Saint Charles, Mo.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Saint Louis Kansas City Short-Line Railway Company, a corporation organized under the laws of the State of Missouri, and its assigns or successors, be, and they are hereby, authorized to construct and maintain a bridge, and approaches thereto, over the Missouri River at the most accessible point between the mouth of the Femme Osage Creek and a point two miles above the city of Saint Charles, in the county of Saint Charles, in the

State of Missouri. Said bridge shall be constructed to provide for the passage of railway trains, and at the option of the corporation or company by which it may be built, may be used for the passage of wagons and, veihcles of all kinds, for the transit of animals, and for foot-passengers for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Passage of railway trains, wagons, etc.,

Tolls.

SEC. 2. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or for passengers and freight passing over said bridge, than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of the other post-roads in the United States.

To be a lawful structure and post-route.

SEC. 3. That if said bridge shall be made with unbroken and continuous spans, the spans thereof shall not be less than three hundred feet in length in the clear, and the main span shall be over the main channel of the river. The lowest part of the superstructure of said bridge shall be at least fifty feet above extreme high-water mark, as understood at the point of location, and the bridge shall be at right angles to and its piers parallel with the current of the river: *Provided*, That if the same shall be constructed as a draw-bridge, the draw or pivot shall be over the main channel of the river at an accessible point, and the spans shall not be less than one hundred and sixty feet in length in the clear, and the piers of said bridge shall be parallel with and the bridge itself at right angles to the current of the river, and the spans shall not be less than ten feet above extreme high water-mark, as understood at the point of location to the lowest part of the superstructure of said bridge: *Provided also*, That said draw shall be opened promptly upon reasonable signal for the passage of boats: and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe. No bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States of the State of Missouri, in which any portion of said obstruction or bridge may be located: *Provided further*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of the river, or to exempt this bridge from the operation of the same.

Spans.

Provisos.
Draw.

Lights, etc.

Free navigation not to be obstructed.

Litigation.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties: *Provided*, That the provisions of section two in regard to charges for passengers and freight across said bridge shall not govern the Secretary of War in determining any question arising as to the sum or sums to be paid to the owners of said bridge by said companies for the use of said bridge.

Other companies to have right of way.

Secretary of War to decide disagreements as to terms, etc.

Proviso.

SEC. 5. That any bridge authorized to be constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secrerary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving,

Plans, etc., to be approved by Secretary of War.

Provisos.
Plans, etc., to approved by Secretary of War.
Right to amend, etc., reserved.
Free navigation not to be obstructed.

the troops, and the munitions of war of the United States than other persons pay for like transportation; and the United States shall have the right of way for a postal telegraph across said bridge: *Provided*, That before this act shall take effect said company shall submit to the Secretary of War the plans and specifications of said bridge, showing the proposed location and structure contemplated, and that it shall be decided by the Secretary that said bridge does not and will not obstruct or impair the navigation of said Red River: *Provided further*, That Congress reserves the right to alter, amend, or repeal this act at any time; and that if at any time navigation of the said river shall in any manner be obstructed or impaired by the said bridge, the Secretary of War shall have authority, and it shall be his duty, to require the said company to alter and change the said bridge, at its own expense, in such manner as may be proper to secure free and complete navigation without impediment; and if upon reasonable notice to said company to make such change or improvements the said company fails to do so, the Secretary of War shall have authority to make the same at the expense of said company, and all rights conferred by this act shall be forfeited; and Congress shall have power to do any and all things necessary to secure the free navigation of the river.

Approved, May 17, 1886.

May 17, 1886.

CHAP. 355.—An act to authorize the construction of a bridge across the Missouri River at some accessible point within two miles north and two miles south of the city of Atchison, in the county of Atchison, in the State of Kansas.

Atchison Bridge Company authorized to build a railroad and wagon bridge across the Missouri River at Atchison, Kans.
Tolls.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Atchison Bridge Company, an incorporation organized under the laws of the State of Kansas, is hereby authorized to construct and maintain a bridge across the Missouri River at such a point as may be hereafter selected by said corporation within two miles north and two miles south of the city of Atchison, in the county of Atchison, in the State of Kansas, as shall best promote the public convenience and welfare and the necessities of business and commerce; and also to construct accessory works to secure the best practicable channel-way for navigation and confine the flow of the water to a permanent channel at such point; and also to lay on and over said bridge a railway track for the more perfect connection of any railroads that are or shall be constructed to said river at or opposite said point; and said corporation may construct and maintain ways for wagons, carriages, and for foot-passengers, charging and receiving reasonable toll therefor as may be approved from time to time by the Secretary of War.

Plans, etc., to be approved by Secretary of War.
Provisos.
Spans.

SEC. 2. That said bridge shall be constructed and built without interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built: *Provided*, That if the said bridge shall be made with unbroken continuous spans, it shall have three or more channel-spans and shall not be of less elevation in any case than fifty feet above extreme high-water mark, as understood at the point of location, to the bottom chord of the bridge; nor shall the spans of said bridge be less than three hundred feet in length, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river, and not less than three hundred feet in length: *And provided also*, That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans of not less than two hundred feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head-room under such span shall not be less than ten feet above high-water mark: *Provided also*, That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe: *Provided also*, That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree.

Draw.

Lights, etc.

Other companies to have right of way.

Secretary of War to decide disagreements as to terms, etc.

SEC. 3. That the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and upon being satisfied that a bridge built on such plan and with such accessory works and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or said accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the circuit court of the United States of the State of Kansas or State of Missouri in which any portion of said obstruction or bridge may be located.

Secretary of War to notify company of approval.

Litigation.

SEC. 4. That the said bridge and accessory works, when built and constructed under this act, and according to the terms and limitations thereof, shall be lawful structures; and said bridge shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post-routes in the United States; and Congress reserves the right at any time to regulate by appropriate legislation the charges for freight and passengers over said bridge.

To be a lawful structure and post-route.

Charges.

SEC. 5. That the United States shall have the right of way for such postal-telegraph lines across said bridge as the Government may construct or control.

Postal-telegraph.

SEC. 6. That Congress shall have power at any time to alter, amend, or repeal this act so as to prevent or remove all material and substantial obstructions to the navigation of said river by the construction of said bridge and its accessory works; and the expense of altering said bridge or removing such obstructions shall be at the expense of the owners of or persons controlling such bridge.

Right to amend, ect., reserved.

Approved, May 17, 1886.

CHAP. 256.—An act to authorize the construction and maintenance of a bridge by the Dakota Central Railway Company, across the Missouri River, at Pierre, Dakota.

May 17, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Dakota Central Railway Company, a corporation duly organized under the general incorporation laws of the Territory of Dakota, its successors and assigns, is hereby authorized to construct and maintain a bridge across the Missouri River at or near the city of Pierre, Hughes County, Dakota, and also to lay on and over said bridge a railway track or tracks for the passage of railway trains; and said corporation may construct and maintain ways for wagons, carriages, and foot-passengers, charging and receiving such reasonable tolls therefor as may be approved, from time to time by the Secretary of War.

Dakota Central Railway Company authorized to bridge the Missouri River at Pierre, Dak.

Wagon and foot bridge.

Tolls.

Plans, etc., to be approved by Secretary of War.

Provisos.

Spans.

Draw.

Lights, etc.

Other companies to have right of way.

Secretary of War to decide disagreements as to terms, etc.

SEC. 2. That said bridge shall be constructed and built without interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the said corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built: *Provided*, That if the said bridge shall be made with unbroken and continuous spans, it shall not be of less elevation in any case than fifty feet above extreme high water mark, as understood at the point of location, to be the lowest part of the superstructure of the bridge, nor shall the spans of said bridge be less than three hundred feet in length, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river and not less than three hundred feet in length: *And provided also*, That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head room under such span shall not be less ten feet above local high-water mark: *Provided also*, That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light House Board shall prescribe: *Provided also*, That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree.

Secretary of War to notify company of approval.

Litigation.

SEC. 3. That the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and upon being satisfied that the bridge built upon such plan with such accessory works, and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same, and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in any circuit court of the United States or any district court of the Territory of Dakota, within whose jurisdiction, any portion of said bridge may be located.

To be a lawful structure and post-route.

Charges.

SEC. 4. That the said bridge and accessory works, when built and constructed under this act and according to the terms and limitatio thereof, shall be lawful structures; and said bridge shall be recogni and known as a post-route, upon which no higher charge shall b made for the transmission over the same of the mails, the troops, a the munitions of war of the United States than the rate per mile pa for the transportation over the railroads or public highways leading such bridge, and said bridge shall enjoy the rights and privileges other post-routes in the United States; and Congress reserves the rig at any time to regulate by appropriate legislation the charges f freight and passengers over said bridge.

Postal-telegraph.

SEC. 5. That the United States shall have the right of way for suc postal-telegraph lines across said bridge as the Government may co struct or control.

Right to amend, etc., reserved.

Sec. 6. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

Approved, May 17, 1886.

May 17, 1886.

CHAP. 357.—An act to authorize the Chicago, Milwaukee and Saint Paul, Railway Company to construct, operate, and maintain a Bridge across the Missouri River near or in the vicinity of Chamberlain in the Territory of Dakota.

Chicago, Milwaukee and Saint Paul Railway Company authorized to bridge the Missouri River at Chamberlain, Dak.

Wagon and foot bridge.

Tolls.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Chicago, Milwaukee and Saint Paul Railway Company shall have the right to construct and maintain a Bridge across the Missouri River near or in the vicinity of the city of Chamberlain, in the Territory of Dakota and also to lay on and over said bridge a railway track or tracks for the passage of railway trains; and said corporation may, at its option, construct and maintain ways for wagons, carriages, and foot-passengers, charging and receiving such reasonable tolls therefor as may be approved from time to time by the Secretary of War.

Free navigation not to be obstructed.

Plans, etc., to be approved by the Secretary of War.

Provisos.

Spans.

Draw.

Lights, etc.

Other companies to have right of way.

Secretary of War to decide disagreements as to terms, etc.

Sec. 2. That said bridge shall be constructed and built without interference with the security and convenience of navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted; and in order to secure that object the said corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built: *Provided*, That if the said bridge shall be made with unbroken and continuous spans, it shall not be of less elevation in any case than fifty feet above extreme high-water mark, as understood at the point of location, to the lowest part of the superstructure of the bridge, nor shall the spans of said bridge be less than three hundred feet in length, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river and not less than three hundred feet in length: *And provided also*, That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall not be less than three hundred feet, and the head room under such span shall not be less that ten feet above local high-water mark: *Provided also*, That said draw shall be opened promptly upon reasonable signal for the passing of boats; and said company or corporation shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light House Board shall prescribe: *Provided also*, That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree.

Secretary of War to notify company of approval.

Sec. 3. That the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and upon being satisfied that the bridge built upon such plan, with such accessory works, and at such locality will conform to the prescribed conditions of this act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to an erection of said bridge, conforming strictly to the approved plan and location; and should any change be made in the plan of the bridge or accessory works, during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in any court of the United States of the Territory of Dakota, of competent jurisdiction, in which any portion of said bridge may be located.

Litigation.

To be a lawful structure and post-route.

SEC. 4. That the said bridge and accessory works, when built and constructed under this act and according to the terms and limitations thereof, shall be lawful structures; and said bridge shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to such bridge, and said bridge shall enjoy the rights and privileges of other post-routes in the United States; and Congress reserves the right at any time to regulate by appropriate legislation the charges for freight and passengers over said bridge.

Charges.

Postal-telegraph.

SEC. 5. That the United States shall have the right of way for such postal-telegraph lines across said bridge as the Government may construct or control.

Right to amend etc., reserved.

SEC. 6. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

Approved, May 17, 1886.

May 20, 1886.

CHAP. 363.—An act to authorize the Covington and Cincinnati Elevated Railway and Bridge Company to erect a bridge across the Ohio River.

Covington and Cincinnati Elevated Railway, Transfer and Bridge Co. authorized to bridge the Ohio River between Covington, Ky., and Cincinnati, Ohio.
Vol. 17, p. 398.
Vol. 22, p. 414.
Proviso.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Covington and Cinnati Elevated Railway, Transfer and Bridge Company, and its successors or assigns, are hereby authorized and empowered to erect a bridge across the Ohio River between Covington, Kentucky, and Cincinnati, Ohio, subject to the limitations and restrictions of the general law regulating the construction of bridges over the Ohio River: *Provided, however*, That said bridge shall not be of less elevation than the Covington and Cincinnati suspension bridge, and may be constructed without a pivot draw-span.

Approved, May 20, 1886.

May 26, 1886.

CHAP. 377.—An act making appropriation to supply deficiency in amount required for expenditure to June thirtieth, eighteen hundred and eighty-six, for examination and surveys required by acts of March third, eighteen hundred and seventy-five, and June nineteenth, eighteen hundred and seventy-eight, to ascertain depth of water and width of channel at South Pass of Mississippi River.

South Pass, Mississippi River.

Deficiency appropriation for examination and surveys to ascertain depth of water and width of channel.
Vol. 18, p. 463.
Vol. 20, p 168.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sum be, and the same is hereby, appropriated out of any money in the Treasury not otherwise appropriated, to wit: To supply deficiency in amount required for expenditure to June thirtieth, eighteen hundred and eighty-six, for examinations and surveys required by acts of March third, eighteen hundred and seventy-five, and June nineteenth, eighteen hundred and seventy-eight, to ascertain the depth of water and width of channel secured and maintained from time to time by James B. Eads at South Pass of the Mississippi River, and to enable the Secretary of War to report to Congress during the maintenance of the work, six thousand four hundred and ninety-two dollars.

Appropriation immediately available.

SEC. 2. That the money hereby appropriated shall be immediately available.

Approved, May 26, 1886.

CHAP. 417.—An act to authorize the construction of a bridge across the Staten Island Sound, known as Arthur Kill, and to establish the same as a post-road.

June 16. 1886

Staten Island Rapid Transit R. R. Co., and Baltimore and New York R. R. Co., authorized to bridge Arthur Kill, Staten Island Sound.

Litigation.

Other companies to have right of way.

Secretary of War to prescribe terms.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the Staten Island Rapid Transit Railroad Company, a corporation existing under the laws of the State of New York, and the Baltimore and New York Railroad Company, a corporation existing under the laws of the State of New Jersey, or either of said companies, to build and maintain a bridge across the Staten Island Sound, or Arthur Kill, from New Jersey to Richmond County, New York, for the passage of railroad trains, engines, and cars thereon, and to lay on and over said bridge railway tracks for the more perfect connection of any railroads that are or shall be constructed to the said sound at or opposite said point; and in case of any litigation concerning any alleged obstruction to the free navigation of said sound on account of said bridge, the cause may be tried before the circuit court of the United States of either of said States in which any portion of said obstruction or bridge touches; and that all railway companies desiring to use the said bridge shall have and be entitled to equal rights and privileges in the passage over the same, and, in the use of the machinery and fixtures thereof and of all the approaches thereto, for a reasonable compensation to be paid to the owners of said bridge under and upon such terms and conditions as shall be prescribed by the Secretary of War upon hearing the allegations and proofs of the parties in case they shall not agree.

Draw.

Proviso. Opening draws

Lights, etc.

SEC. 2. That said bridge shall be constructed as a pivot drawbridge, with a draw over the main channel of the sound at an accessible and navigable point, and with spans of not less than two hundred feet in length in the clea on each side of the central or pivot pier of the draw; and said spans shall not be less than thirty-two feet above mean low-water mark measuring to the lowest member of the bridge superstructure: *And provided also,* That said draw shall be opened promptly, upon reasonable signal, except when trains are passing over the said bridge, for the passage of the boats whose construction shall not be such as to admit of their passage under the draw of said bridge when closed: but in no case shall unnecessary delay occur in opening the said draw after the passage of trains; and the said company or corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe.

To be a lawful structure and post-route.

Postal telegraph.

SEC. 3. That any bridge constructed under this act and according to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for their transportation over the railroads or public highways leading to said bridge; and the United States shall have the right of way for postal-telegraph purposes across said bridge.

Plans, etc., to be approved by Secretary of War.

To be finished in two years.

SEC. 4. That the plan and location of said bridge, with a detailed map of the sound at the proposed site of the bridge and near thereto, exhibiting the depths and currents, shall be submitted to the Secretary of War for his approval, and until he approve the plan and location of said bridge it shall not be built; but upon the approval of said plan by the Secretary of War the said companies, or either of them, may proceed to the erection of said bridge in conformity with said approved plan; and should any change be made in the plan of said bridge during the progress of the work thereon, such change shall be subject likewise to the approval of the Secretary of War. If the Secretary of War shall at any time deem any change or alteration necessary in the said bridge, so that the same shall not obstruct navigation, or if he shall think the removal of the whole structure necessary, the alteration so required or the removal of the whole structure, shall be made at the expense of the parties owning said bridge; and if said bridge shall not be finished within two years from the passage of this act, the rights and privileges hereby granted shall determine and cease.

Right to amend, etc., reserved.

SEC. 5. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, June 16, 1886.

June 21, 1886.

CHAP. 463—An act to authorize the purchase of the Aqueduct Bridge or the construction of a bridge across the Potomac River at or near Georgetown, District of Columbia.

Aqueduct Bridge, Potomac River.

Purchase of.

To be a free bridge.

Appropriation.

District of Columbia to pay one-half.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War is hereby authorized and directed to acquire by purchase a title in fee simple, free from all liens or claims of lessees or others, the bridge known as the Aqueduct Bridge, including the piers thereof, across the Potomac River, and the approaches thereto and all the rights and franchises connected with said bridge, for a sum not to exceed one hundred and twenty-five thousand dollars, the title to be approved by the Attorney-General of the United States; and said bridge, when so acquired, shall be used as a free bridge, under such regulations as the Secretary of War may prescribe: and the Secretary of War is further authorized, in case the United States shall acquire title to the said bridge, to repair or reconstruct the same; and for the purpose of acquiring such title and repairing and reconstructing said bridge the sum of two hundred and forty thousand dollars, or so much thereof as may be necessary for such purpose, is hereby appropriated, out of any money in the Treasury not otherwise appropriated; and one half of the expense of such purchase and reconstruction or repair of said bridge shall be charged to and paid by the District of Columbia, and the balance. one-half of the sum so expended, shall be paid out of the Treasury of the United States.

Bridge to be built at Three Sisters if Aqueduct Bridge not purchased in six months.

Appropriation.

Provisos.

Cost.

Bridge over Chesapeake and Ohio Canal.

District of Columbia to pay one-half.

Surveys, &c.

Advertisement.

Part of appropriation immediately available.

SEC 2. That if the provisions of the first section of this act authorizing the purchase of the Aqueduct Bridge shall not be fully executed within six months from the passage of this act, and the title therefor approved as therein required, then the Secretary of War be, and he is hereby, authorized and directed to cause to be constructed across the Potomac River at the Three Sisters, above Georgetown, in the District of Columbia, a substantial iron and masonry bridge, with approaches: and the sum of two hundred and twenty thousand dollars be, and the same is hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the construction of said bridge and approaches, the same to be maintained as a free bridge for travel: *Provided*, That the said Secretary of War shall construct a bridge upon such a plan as shall cost no more than the amount herein appropriated, and which cost shall include the construction of a substantial iron bridge over the Chesapeake and Ohio Canal and highway, and any and all approaches to the said iron bridge, which said bridge shall not be less than fourteen feet in the clear above the water-line of said canal; and not exceeding fifteen thousand dollars of this appropriation shall be paid out of the Treasury until contracts shall have been entered into with responsible parties, and with good and sufficient sureties, to be approved by the Secretary of War, for the construction and completion of said bridges across the Potomac River and the Chesapeake and Ohio canal, including the masonry, iron-work, and approaches, at a cost not to exceed in the agregate two hundred and twenty thousand dollars. less such sum as may be expended for advertising and making necessary survey: *And provided also*, That one-half of the expense of the construction of said bridge shall be charged to and paid by the District of Columbia, and the balance (one-half) of the sum hereby appropriated shall be paid out of the Treasury of the United States: *Provided further*, That the Secretary of War shall, as soon as possible, cause a survey of the river to be made at the Three Sisters, determine the length, width, and height of said bridge, and thereupon advertise for plans and price for the construction of said bridge, such advertisement to be inserted in one or more daily newspapers published in Washington, District of Columbia; New York; Cleveland, Ohio; Detroit, Michigan; Philadelphia, Pennsylvania; Chicago, Illinois; Richmond, Virginia; Saint Louis, Missouri, for the space of one week: *And provided further*, That the sum of fifteen thousand dollars shall be available at once for such investigation and surveys and such contingencies as the Secretary of War shall deem necessary.

Condemnation to secure title.

SEC. 3. That if in the purchase of the Aqueduct Bridge under the first section, at any time, it shall be deemed necessary to obtain from the Chesapeake and Ohio Canal Company, or its grantees, any release or conveyance of any portion of the ground upon which the northern abutment of the Aqueduct Bridge rests, or right to cross the Chesapeake and Ohio Canal from the abutment to Bridge street, or if a good title cannot be procured by contract to any property required in the construction of a bridge under the second section, the same shall be acquired by the Secretary of War by condemnation in the manner provided by the act approved May eighth, eighteen hundred and seventy-two, entitled "An act making appropriations for the legislative, executive, and judicial expenses of the Government for the year ending June thirtieth, eighteen hundred and seventy-three, and for other purposes:" *Provided*, That the condemnation proceedings, if any such proceedings are necessary, shall not prevent the taking possession, on payment of the purchase money, of the Aqueduct Bridge by the United States, and opening the same to the public as a free bridge, if the same shall be acquired under the first section: *Provided further*, That the sum of ten thousand dollars of the sum hereby appropriated shall be available to meet the payments under condemnation proceedings, if any shall be had.

Vol. 17, p. 84.

Proviso.

Condemnation proceedings not to prevent taking possesion.

Condemnation expenses immediately available.

SEC. 4. The act approved February twenty-third, eighteen hundred and eighty-one, entitled "An act to authorize the construction of a bridge across the Potomac River at or near Georgetown, in the District of Columbia, and for other purposes," is hereby repealed.

Vol. 21, chap. 69, p. 328, repealed.

Approved, June 21, 1886.

CHAP. 574—An act making appropriations for the support of the Army for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, and for other purposes.

June 30, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the support of the Army for the year ending June thirtieth, eighteen hundred and eighty-seven:

Army appropriations.

* * * * * * *

For additional pay to officer in charge of public buildings, and so forth, in Washington, District of Columbia, five hundred dollars.

Charge of public buildings, Washington.

* * * * * * *

ENGINEER DEPARTMENT.

Engineer depot at Willets Point, New York: Incidental expenses of the depot: Fuel, chemicals, stationery, extra-duty pay for soldiers employed in wheelwright's work, engine-driving, draughting, printing, photographing, and lithographing engineer documents, repairs of public buildings, and unforeseen expenses, three thousand dollars.

Engineer Department.

Incidental expenses.

For purchase of materials for the instruction of engineer troops at Willits Point in their special duties of sappers, miners, and pontoneers, one thousand dollars.

Materials for instruction of engineer troops.

For repairs of instruments for general use of the Corps of Engineers, and for the purchase of small instruments to fill requisitions, two thousand dollars.

Repairs of instruments.

Library of the Engineer School of Application: Purchase of professional works of recent date treating of military and civil engineering, five hundred dollars.

Library.

For construction of a new building to contain the officers' mess, the library, and draughting-rooms of the School of Application; ten thousand dollars, to be immediately available, or so much thereof as may be necessary: *Provided*, That the cost of the building complete for use and occupation shall not exceed ten thousand dollars.

Building.

Proviso.

Cost.

* * * * * * *

Approved June 30, 1886.

CHAP. 623.—An act to authorize the improvement of the water-power of the Mississippi River at Little Falls, Minnesota.

July 3, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the Little Falls Water-Power Company of Minnesota to improve and develop the water-power of the Mississippi River at Little Falls, in the State of Minnesota, by constructing, maintaining, and operating in said river, at said Little Falls, dams, piers, sluice ways, canals, locks, ponds, break-waters, abutments, and mill sites for manufacturing pur-

Little Falls Water-Power Company may build dam, etc., at Little Falls, Mississippi River, Minn.

Provisos.
Sluice-way, etc., for passage of logs, etc.
Changes.

poses: *Provided*, That there shall be placed and maintained in con nection with said dam and other works a sluice-way, lock, or othe fixture sufficient and so arranged as to permit logs, timber, and lumbe to pass around, through, or over said dam or other works without unreasonable delay or hindrance, and without tolls or charges: *Provided*, *further*, That the Secretary of War may at any time require such changes and alterations to be made in said works, at the expense o said water-power company, as he may deem advisable and necessar in the interest of navigation.

SEC. 2. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, July 3, 1886.

July 8, 1886.

CHAP. 747.—An act to * * * provide for the sale of the old site of Fort Brady Michigan, and for a new site and the construction of suitable buildings thereon.

Be it enacted by the Senate and House of Representatives of the Unit States of America in Congress assembled,

* * * * * * *

Fort Brady military reservation, Michigan, to be sold; exception.
Property to be platted and sold in lots.
Expenses.
Proceeds.

SEC. 3. That the Secretary of War is hereby authorized to sell t military reservation known as Fort Brady, in the village of Sault Sain Marie, in the State of Michigan, except that portion lying north o Water street extended, which shall be reserved for canal and wharf pu poses, and except the plat of ground now occupied as a military cem tery, which shall also be reserved. In disposing of said property t Secretary of War shall cause the grounds to be platted in blocks, street and alleys, corresponding as near as may be with the plat of the villa of Sault Sainte Marie, and in lots not exceeding one-quarter of an ac in each, unless with due reference to the requirements of the hous and buildings now located on said grounds. The Secretary of W shall also cause the lots to be appraised and sold at public or priva sale, at not less than the appraised value, having first been offered a public sale. The expense of advertising, appraisement, survey, an sale shall be paid out of the proceeds of said sale, and the balance pa into the Treasury of the United States.

Secretary of War to purchase grounds in or near Sault Ste Marie, Mich., and construct military post called Fort Brady.
Appropriation.
Proviso.
Title.

SEC. 4. That the Secretary of War is also authorized to purcha grounds in or near the village of Sault Sainte Marie, suitable and su ficient for fortifications and for garrison purposes and construct there the necessary buildings, with appurtenances, sufficient for a four com pany military post, to be known as Fort Brady, in accordance with e timates to be prepared by the War Department; and a sufficient su of money, not exceeding one hundred and twenty thousand dollars, hereby appropriated, out of any money in the Treasury not otherwi appropriated, to enable the Secretary of War to comply with the pro visions of this act: *Provided*, That the title to lands authorized to b purchased under the fourth section of this act shall be approved by th Attorney-General.

Ground for public park may be reserved.

SEC. 5. That in platting these grounds the Secretary of War, in hi discretion, may reserve all that part of the reservation lying south o Portage street, to be set apart and kept by the municipal authoriti of Sault Sainte Marie, as a public park for its citizens and the peop of the United States.

New site to be purchased before sale of old.

SEC. 6. That section three of this act shall not be of effect until th purchase of a new site, provided for in section four, shall have be effected.

Approved, July 8, 1886.

July 9, 1886.

CHAP. 757.—An act making appropriations to provide for the expenses of the government of the District of Columbia for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, and for other purposes.

District of Columbia appro

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the half of the following sums named, respectively, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, and the other half out of the revenues of the District of Columbia, for the purposes following, being the estimated expenses of the government of the District of Columbia for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, namely:

FOR SALARIES AND CONTINGENT EXPENSES.

Salaries and contingent expenses.

Commissioners

For executive office: * * * * one engineer commissioner, nine hundred and twenty-four dollars (to make salary five thousand dollars);

* * * * *

WASHINGTON AQUEDUCT.

Washington Aqueduct.

For engineering, maintenance, and general repairs, twenty thousand dollars.

* * * * *

Approved, July 9, 1886.

July 10, 1886.

CHAP. 759.—An act to authorize the construction of a bridge across the Missouri River at or near the city of Saint Joseph, in the State of Missouri, and to establish it as a post-road.

Saint Joseph and Rio Grande Railroad Company, authorized to bridge Missouri River, at Saint Joseph, Mo.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Saint Joseph and Rio Grande Railroad Company of the State of Kansas, its successors or assigns, are hereby, authorized to build a bridge across the Missouri River at or near the city of Saint Joseph, in the State of Missouri, and to lay on or over said bridge railway tracks for the more perfect connection of any railroads that are or shall be constructed to the said river at or opposite said point, under the limitations and conditions hereinafter provided: *Provided,* That said bridge shall not interfere with the free navigation of said river beyond what is necessary to carry into effect the rights and privileges hereby granted.

Proviso.

Free navigation not to be impaired.

Construction.

SEC. 2. That any bridge built under the provisions of this act may, at the option of the company building the same, be built either as a pivot draw-bridge or with unbroken or continuous spans: *Provided,* That if the said bridge shall be made with unbroken and continuous spans, it shall not be of less elevation in any case than fifty-feet above high-water mark, as understood at the point of location, to the bottom chord of the bridge, nor shall the spans of said bridge be less than three hundred feet in length, and the piers of said bridge shall be parallel with the current of the river, and the main span shall be over the main channel of the river and not be less than three hundred feet in length: *And provided also,* That if any bridge built under this act shall be constructed as a pivot draw-bridge, the same shall be constructed with a draw over the main channel of the river at an accessible and navigable point, with spans not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw; and the next adjoining spans to the draw shall be not less than three hundred feet, if the proper location of the draw over the channel will admit spans of this width between it and the shore; and said spans shall not be less than thirty feet above low-water mark, and not less than twenty feet above extreme high-water mark, measuring to the bottom chord of the bridge; and the piers of the said bridge shall be parallel with the current of the river: *And provided also,* That said draw shall be opened promptly, upon reasonable signal, for passage of boats

Provisos.

Spans.

Draw.

Construction of a low bridge.

SEC. 3. That in case said bridge be constructed as a low bridge, there shall be at least one protection-pier of masonry, crib-work, or piling extending from the upper end of a pivot-pier or one of the rest piers of a draw-span, up stream, for a distance of not less than five hundred feet from the centre line of the bridge, or such other distance as may be determined by the Secretary of War, which protection-pier shall be properly arranged with ring-bolts and fender-planking so as to enable boats to tie up alongside of it and drop down through the draw-openings at such times as it may be dangerous to attempt the passage of the draw-opening under headway. That all draw or pivot spans authorized by this act shall be operated by steam or other reliable mechanical power, and shall be opened promptly upon reasonable

Opening draw.

signal for the passage of boats, except when trains are passing over said span or spans; but in no case shall unnecessary delay occur in opening said draw after the passage of trains; and in case the opening of a draw be delayed by reason of the passing of a train after the signal has been given from a boat ready to pass through, the draw shall be opened for the passage of such boat before another train is allowed to pass over the bridge. That the piers of all high channel spans and all pivot-spans shall be built parallel with the current of the river at that stage of water which is most important for navigation; and riprapping, or other protection for imperfect foundations which will materially lessen the water way, shall not be employed in the channel-ways of the high spans or of the draw-openings, and piers which will produce cross-currents or bars dangerous to navigation shall not be constructed, and if, after construction, any piers or protection-walls are found to produce the above mentioned effects, the nuisance shall be abated or corrected by or at the expense of the persons owning said bridge. That in case the approaches to draw-span opening, channel-spans, or raft-passages in said bridge be found dangerous or difficult of access by any important class of river traffic, the Secretary of War shall order the construction of such sheer-booms, guide-piers, or other similar device as will obviate the difficulty, which sheer-booms, guide-piers, or other device shall be paid for by the persons owning said bridge. That the persons owning, controlling, or operating the bridge authorised by this act shall maintain, at their own expense, from sunset to sunrise, throughout the year, and during heavy fogs, such lights or other signals as the Light-House Board shall prescribe, and shall, in case a high bridge be constructed, during the season of navigation, have posted in a conspicuous place on or near the bridge the clear head-room under the channel-span on that day, the figures expressing this height to be not less than two feet high, and to be readily visible from any point in the channel of the river for a stretch of three thousand feet above and one thousand feet below the bridge.

Aids to navigation.

Lights, etc.

To be a lawful structure and post route.

SEC. 4. That any bridge constructed under this act and according to its limitations shall be a lawful structure and shall be known and recognized as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for their transportation over the railroads or public highways leading to the said bridge.

Other companies to have use of.

Secretary of War to prescribe terms.

SEC. 5. That all railway companies desiring to use the said bridge shall have and be entitled to equal rights and privileges in the passage of the same and in the use of the machinery and fixtures thereof, under and upon such terms and conditions as shall be prescribed by the Secretary of War upon hearing the allegations and proofs of the parties in case they shall not agree.

Secretary of War to approve plans, locations, etc.

SEC. 6. That any bridge constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company shall submit to the Secretary of War, for his examination and approval, a design of the drawings of the bridge and piers and a map of the location, giving, for the space of at least one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and until said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and if any change be made in the plan of construction of said bridge during the progress of the work thereon, or before the completion of said bridge, such change shall be subject to the approval of the Secretary of War; and the said structure shall be at all times so kept and managed as to offer reasonable and proper means for the passage of vessels through or under said structure; and the said structure shall be changed at the cost and expense of the owners thereof, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to the revocation or modification by law whenever the public good shall, in the judgment of

Congress, so require, without any expense or charge to the United States; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river caused or alleged to be caused by said bridge, suit may be brought in the circuit courts of the United States of Missouri or Kansas in whose jurisdiction any portion of said bridge may be located.

Litigation.

SEC. 7. That the right to alter, amend, or repeal this act is hereby expressly reserved; and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

Right to amend, etc., reserved.

Approved, July 10, 1886.

CHAP. 775.—An act to authorize the construction of a railroad, wagon, and foot-passenger bridge across the Mississippi River at or near Dubuque, in the State of Iowa.

July 19, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Chicago, Burlington and Northern Railroad Company, its successors and assigns be, and they are hereby, authorized to construct and maintain a railroad, wagon, and foot-passenger bridge across the Mississippi River at a suitable point in the vicinity of the city of Dubuque, in the State of Iowa, and to lay on or over said bridge a railroad track or tracks for the more perfect connection of any railroad or railroads that are or shall be constructed to said river, on either or both sides thereof, at or opposite said point, under the limitations and conditions hereinafter provided; that said bridge shall not interfere with the free navigation of said river beyond what is necessary in order to carry into effect the rights and privileges hereby granted; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, the cause may be tried before the circuit court of the United States in and for any district in which any portion of said bridge or obstruction touches. Said bridge shall be constructed to provide for the passage of railroad trains, and for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot-passengers, for such reasonable rates of toll as may be fixed from time to time by the Secretary of War: *Provided*, That the proviso regarding wagons, animals, foot-passengers, and so forth, shall not influence the location of said bridge in its relation to the interests of navigation.

Chicago, Burlington and Northern Railroad Company authorized to bridge the Mississippi River.

Railroad, wagon, and foot-bridge.

Free navigation not to be impaired.

Litigation.

Tolls.

Proviso.

Location.

SEC. 2. That any bridge built under the provisions of this act may, at the option of the company building the same, be built as a drawbridge or with unbroken and continuous spans: *Provided*, That if the said bridge shall be made with unbroken and continuous spans, it shall give clear head-room of not less in any case than fifty-five and one-half feet above extreme high-water mark, as understood at the point of location, nor shall the spans of said bridge give a clear width of water-way of less than two hundred and fifty feet, and the piers of said bridge shall be parallel with the current of said river, and the main span shall be over the main channel of the river and give a clear width of water-way of not less than three hundred feet: *And provided further*, That if any bridge built under the provisions of this act shall be constructed as a draw-bridge, the same shall be constructed as a pivot draw-bridge, with a draw over the main channel of the river at an accessible and navigable point, and with spans giving a clear width of waterway of not less than one hundred and sixty feet on each side of the central or pivot pier of the draw, and the next adjoining span or spans to the draw shall give a clear width of water-way of not less than two hundred and fifty feet: *Provided*, That if the pivot-pier of said bridge shall be constructed within less than four hundred and ten feet of the east shore of said river, the span constructed east of said pivot-pier may be less than two hundred and fifty feet, and said spans shall give clear head-room of not less than thirty feet above low-water mark, and not less than ten feet above extreme high-water mark and the piers of said bridge shall be parallel with the current of the river where said bridge shall be erected: *And provided also*, That said draw shall be opened promptly upon reasonable signal for the passage of boats, except when trains are passing over the draw; but in no case shall unnecessary delay occur in opening the said draw during or after the passage of trains. In the event that

Construction.

Provisos.

Spans.

Draw.

Location of pivot-pier.

Opening draw.

the bridge herein provided for, or any part thereof, shall be constructed within seven hundred and fifty feet south of the present bridge between Dubuque and East Dubuque, any expenditures that may hereafter be made by the owners of the bridge now constructed for the purpose of guarding against casualties by floods or ice, and made either north of the present bridge or around the piers of the same, shall be borne in equal parts by the two companies, respectively, and paid for as the work progresses; and any expenditures which have been made or that may be hereafter made for the purpose of complying with existing laws or laws hereafter enacted for the protection of navigation, by means of sheerbooms or otherwise, shall be borne equally by the two companies aforesaid: *Provided*, That in the location of the piers of said bridge, if made within seven hundred and fifty feet, due regard shall be had to the existing structure, and said piers shall be so constructed as not to increase the danger of the same either from floods or ice.

Protection against damage by floods or ice.

To be a lawful structure and post-route.

SEC. 3. That any bridge constructed under this act and according to its limitations shall be a lawful structure, and shall be known as a post-route, and the same hereby declared to be a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, or for passengers or freight passing over said bridge, than the rate per mile paid for their transportation over the railroads and public highways leading to said bridge; and the United States shall have the right of way for postal telegraph purposes across said bridge.

Postal telegraph.

Other companies to have right of way.

SEC. 4. That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree.

Secretary of War to prescribe terms.

SEC. 5. That the structure herein authorized shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as shall be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are decided by the Secretary of War to be such as will not materially affect the interests of navigation the bridge shall not be commenced or built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War; and the said structure shall be at all times so kept and managed as to offer reasonable and proper means for the passage of vessels through or under said structure; and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights as may be prescribed by the Secretary of War; and the said structure shall be changed or removed at the cost and expense of the owners thereof, from time to time as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to revocation and modification by law when the public good shall, in the judgment of Congress, so require, without any expense or charge to the United States.

Plans, etc., to be approved by Secretary of War.

Ligh

Right to amend, etc., reserved.

SEC. 6. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, July 19, 1886.

CHAP. 778.—An act to provide for the construction of a bridge across the west channel of the Detroit River to connect Belle Isle Park with the mainland.

July 20, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the assent of Congress is hereby given to the municipality known as the city of Detroit, a body corporate existing by and under the laws of the State of Michigan, to erect a bridge across the Detroit River between any point on the northwestern bank of said river within the limits of said corporation aforesaid and the island in the Detroit River heretofore known as Belle Isle, and now known and designated as Belle Isle Park, the said bridge to be devoted to such general use as may be prescribed by the municipal authorities of the city of Detroit.

City of Detroit authorized to bridge Detroit River between the city and Belle Isle Park.

SEC. 2. That the bridge authorized to be erected by this act shall be so located and constructed that the channel of said Detroit River shall not be unreasonably obstructed, but that a draw or pivot span of not less than one hundred and twenty-five feet clear opening on each side of the pivot-pier shall be located over the above-specified channel in such a manner that one or both of the openings of said draw or pivot span can be conveniently and safely reached and passed by boats pursuing the ordinary channel of the river; that one opening at least of a draw or pivot span shall be over the best and most convenient channel of the river for such classes of river traffic as shall find it convenient to use said channel.

Not to obstruct navigation.

Draw.

SEC. 3. That the height at which said bridge shall be constructed above the surface of the river shall be such as may be approved by the Secretary of War.

Height.

SEC. 4. That all draw or pivot spans authorized by this act shall be operated by steam or other reliable mechanical power, and shall be opened promptly upon such signals as are now prescribed by law for the passage of boats through draw or bridges, and such other and further regulations as may be prescribed in the premises.

Draw to be operated by steam.

SEC. 5. That piers upon which said bridge is built shall be parallel with the current of the river, and so as to avoid producing cross-currents or bars dangerous to navigation; and if, after construction, any piers are found to produce the above-mentioned effects, the nuisance shall be abated or corrected by or at the expense of the corporation owning or operating said bridge, and when advised by the Secretary of War.

Piers.

SEC. 6. That it shall be the duty of the municipal corporation authorized to erect a bridge under this act to maintain, at its own expense, from sunset to sunrise of each day throughout the season of navigation, and during heavy fogs, such lights on the bridge as may be required by the Light-House Board for the security of navigation.

Lights.

SEC. 7. That any bridge constructed under this act and according to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, over which the mails, troops, and munitions of war of the United States may be transported at no higher charge than is made for transportation of said mails, troops, and munitions of war over railroads and public highways leading to said bridge; and the United States shall have the right of way for postal-telegraph lines and appliances across said bridge.

To be lawful structure and post-route.

Postal telegraph.

SEC. 8. That before commencing work on the bridge contemplated in this act it shall be the duty of the municipal authorities of the city of Detroit to submit to the Secretary of War, for his examination, a design and drawing of the bridge and piers, and a map of the location, giving, for the space of one-half mile above and one-half mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction of the current, and soundings showing accurately the bed of the stream, and such other and further information as the Secretary of War may require for a full and satisfactory understanding of the subject.

Secretary of War to approve plans, etc.

SEC. 9. That when the Secretary of War is satisfied that the provisions of this act have been complied with in the matter of location and the submission of plans, the building of the piers may at once commence; but if it shall appear that the conditions prescribed by this act cannot be complied with at the location where it is desired to construct the bridge, the Secretary of War shall, after considering all remonstrances filed against the building of said bridge, and furnishing copies of remonstrances to the board of engineers provided for in this act, detail a board of experienced engineers from the Engineer Corps

Construction to begin when Secretary of War is satisfied as to plans, etc.

Remonstrances.

of the United States Army to examine the case, and may, on the recommendation, authorize and direct such modifications as appe necessary.

Board of Army engineers to supervise the work.

SEC. 10. That the Secretary of War may, in his discretion, appoi one or more Army engineers to supervise and personally examine th construction of said bridge: and that the proposed bridge shall on be a lawful structure when built as approved by the Secretary of Wa who shall have authority, by and with the advice of the engineers d tailed by him, to order such change in construction or appliances he may deem necessary for the safety of said bridge and the conve ience of navigation.

Litigation.

SEC. 11. That in case of any litigation from any obstruction, or alleg obstruction, to navigation created by the construction of any brid under this act, the cause or question arising may be heard by the Di trict Court of the United States of any State in which any portion said obstruction or bridge touches.

Municipal law, to extend to bridge.

SEC. 12. That the municipal laws and ordinances of the city of D troit may be enforced on said bridge, and the care, control, and the of the same shall be governed by ordinances of the city enacted, though said bridge was a public street in said city.

Right to amends etc., reserved.

SEC. 13. That the right to alter, amend, or repeal this act, and require the removal of material obstructions to navigation by the c struction of any bridge under its provisions, is hereby expressly served, without any liability of the Government for damages on count of such alterations, amendment, or repeal, or on account of t prevention or the requiring of the removal of any such obstructi and if any change be made in the plan of any bridge constructed und this act, during the progress of the work thereon or before the co pletion of said bridge, such change shall be subject to the approval the Secretary of War; and any change in the construction or any alt ation of any such bridge, and the removal of any such obstruction, th may be directed at any time by Congress or the Secretary of War, sh be made at the cost and expense of the owners of the said bridge.

Approved, July 20, 1886.

July 29, 1886.

CHAP. 802.—An act to authorize the Bellingham Bay Railway and Navigation Co pany to build certain bridges in the Territory of Washington.

Bellingham Bay Railway and Navigation Company authorized to build bridges, Washington Territory.

Nooksack River.

Skagit River.

Stillaquamish River.

Snohomish River.

Wagon and foot bridges.

Tolls.

Right to cross Lake Union or Salmon Bay.

Draw.

Be it enacted by the Senate and House of Representatives of the Uni States of America in Congress assembled, That the Bellingham Bay Ra way and Navigation Company, a corporation duly organized under th laws of Washington Territory, its successors or assigns, be, and hereby, authorized to construct, maintain, and operate bridges, and approaches thereto, over the Nooksack River, in the county of Whatcom, the Skagit River, in the county of Skagit, and the Stillaquamish and Snohomish Rivers, in the county of Snohomish, at the points where the said company's line of railways, as now projected, cross said rivers respectively; said bridges shall be constructed to provide for the passage of railway trains, and, at the option of said company by which the same or either of the same shall be built, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot-passengers, for reasonable rates of toll to be fixed by said company; but such rates shall be reasonable rates, and the Secretary of War shall have the right from time to time to revise, prescribe, and fix the same. Said company shall also have the right to cross either Lake Union or Salmon Bay (sometimes called Shilshole Bay), or the waters between, or the canal built or to be built between said Lake Union and said bay. Said works to contain a draw of such width as shall accommodate the commerce passing through said waters, and to be built upon plans to be approved by the Secretary of War, as provided in section two of this act, and subject to be changed, enlarged, and altered from time to time as the Secretary of War or Congress shall from time to time direct, and as the exigencies of commerce may require.

Plans subject to approval of Secretary of War

SEC. 2. That the plan and location of any bridge the construction of which is hereby authorized shall be subject to the approval of the Secretary of War; and each of the same shall be so located as not materially to obstruct or impair the free navigation of such rivers respectively or said canal, and shall be built with piers parallel to the current, leaving the water-way unobstructed by riprap, or piling, or other

Draw.

Lights.

Proviso.
Construction to await Secretary of War's approval.

obstructions, and shall have at the crossing of each of the main channels of said rivers or said canal (unless the same shall be built above the head of navigation) a draw of the width to be fixed by the Secretary of War, which shall be located at the points best calculated to accommodate commerce, to be determined by the Secretary of War; which draws shall at all times be opened promptly for passing vessels, upon reasonable signal, except when railway trains are passing over the same; and at all times during the season of navigation proper signal-lights shall be used and maintained, at the expense of the aforesaid company, its successors and assigns, to guide vessels approaching said draws: *Provided*, That the construction of neither of said bridges shall be commenced until the plan location, and width of draw thereof has been approved by the Secretary of War, and the said company has been notified in writing of the same.

To be lawful structure and post-route.

Changes.

SEC. 3. That any bridge built under this act shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to such bridge; and it shall enjoy the rights and privileges of other post-routes in the United States. And the said structure shall be changed, at the cost and expense of the owners thereof, or persons controlling or operating the same, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said rivers and bays; and the authority to erect and continue any and all said bridges shall be subject to revocation by law whenever the public good shall, in the judgment of Congress, so require; and all such structures shall, upon such revocation, be removed, at the expense of the owners thereof, or the persons controlling and operating the same.

Litigation.

Proviso.
Navigation not to be impaired.

SEC. 4. That in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said rivers and waters caused or alleged to be caused by said bridges or other obstructions, the case may be brought in the district court of the district where such obstruction is alleged to exist, unless meanwhile the portion of said Territory where said erection exists shall have been admitted into the Union as a State, in which case the same may be brought in the circuit court of the United States of such State: *Provided*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt said bridges from the operation of the same.

Right to amend, etc., reserved.

SEC. 5. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, July 29, 1886.

July 29, 1886.

CHAP. 804.—An act to grant the Astoria and Winnemucca Railroad Company the right to construct bridges over navigable water-courses.

Astoria and Winnemucca Railroad Company authorized to bridge the Willamette River and other navigable water-courses, Oregon.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of the Government is hereby given to the Astoria and Winnemucca Railroad Company, a corporation duly organized under the laws of Oregon, to build railroad bridges across the Willamette River, south of Oregon City, at such point as it may select, and across such other navigable streams or sloughs within the State of Oregon as it may be necessary to bridge along the line of said railroad or along the line of any of its branches.

Construction.

Provisos.
Spans.

Draw.

SEC. 2. That any bridge built under the provisions of this act may, at the option of said railway company, be built as a draw-bridge or with unbroken and continuous spans: *Provided*, That if any such bridge shall be made with unbroken and continuous spans, the main span shall be over the main channel of such navigable river or slough, and shall be of such width, and the lowest part of the superstructure shall be of such height above extreme high-water mark, as the Secretary of War may prescribe, and such bridge shall be at right angles to and its piers parallel with the current or channel of the river or slough over which it may be constructed; and if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed with an opening over the center of the channel of the river or slough, and shall be of such width, character, and construction as the Secretary of War

Lights, etc.

May be wagon and foot bridges.

Tolls.

shall prescribe, and the piers of said bridge shall be parallel with the current, and the draws of said bridge shall be over the main or deep channel of the river or slough, as may be fixed and determined by the Secretary of War: *Provided also*, That said drawers shall be opened promptly upon reasonable signal for the passage of boats, and in no case shall unnecessary delay occur; and said company or corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light House Board shall prescribe: *Provided also*, That said bridge or bridges, at the option of the corporation or company by which it may be built, may be used for the passage of wagons or vehicles of all kinds, for the transit of animals, and for foot-passengers, for such reasonable rate of toll as may be approved from time time by the Secretary of War.

To be lawful structure and post-routes.

Postal telegraph.

Plans, etc., to be approved by Secretary of War.

SEC. 3. That any bridge authorized to be constructed under this act shall be a lawful structure, and shall be recognized and known as a post-route, and it shall enjoy the rights and privileges of other post-roads in the United States, upon which also no higher charge shall be made for transmission over the same of the mails, the troops, and the munitions of war of the United States, or for through passengers or freight passing over said bridge or bridges, than the rate per mile for their transportation over the railroads leading to the said bridge or bridges; and the United States shall have the right of way for a postal telegraph across said bridge or bridges. Said bridge or bridges shall be built and located under and subject to such regulations for the security of navigation of navigable rivers or sloughs as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of any such bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river or slough, the shore-line at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed and channel of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plans and location of the bridge or bridges are approved by the Secretary of War the bridges shall not be built; and should any change be made in the plan of any such bridge during the progress of construction thereof, such change shall be subject to the approval of the Secretary of War.

Other companies to have right of way.

Terms to be decided by Secretary of War.

SEC. 4. That all railroad companies desiring the use of any bridge constructed under this act shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

Changes.

Right to amend, etc., reserved.

SEC. 5. That such alterations or changes as may be required by the Secretary of War or Congress in bridges constructed under the provisions of this act shall be made by the persons or corporations owning or controlling said bridges, at their own expense; and it is hereby expressly provided that Congress reserves the right at any time to alter, amend, or repeal this act.

Approved, July 29, 1886.

July 29, 1886.

CHAP. 805.—An act authorizing the city of Salem to construct a bridge across the Willamette River, in the State of Oregon.

Salem, Oregon, authorized to build wagon and foot bridge across Willamette River.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the city of Salem, in the county of Marion and State of Oregon, be authorized and permitted to build a wagon and foot bridge across the Willamette River at such point as it may select opposite said city and between the counties of Marion and Polk, in the State of Oregon. Such bridge may also, at the option of said city, be so constructed as to be available as a railroad bridge.

Construction.

SEC. 2. That such bridge built under the provisions of this act may,

Provisos.
Spans.
Draw.
Opening draw.
Lights, etc.
Tolls.
May be free bridge.

at the option of said city of Salem, be built as a draw-bridge or with unbroken and continuous spans: *Provided*, That if such bridge shall be made with unbroken and continuous spans, the main span shall be over the main channel of such navigable river, and shall be of such width, and the lowest part of the superstructure shall be of such height above extreme high-water mark, as the Secretary of War may prescribe; and such bridge shall be at right angles to and its piers parallel with the current or channel of the said river. And if such bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed with an opening over the center of the channel of the river, and shall be of such width, character, and construction as the Secretary of War shall prescribe; and the piers of said bridge shall be parallel with the current, and the draws of said bridge shall be over the main or deep channel of the river, as may be fixed and determined by the Secretary of War: *Provided also*, That said draws shall be opened promptly upon reasonable signal for the passage of boats, and in no case shall unnecessary delay occur; and said city of Salem shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe: *Provided also*, That said bridge at the option of the said city of Salem, by which it may be built, may be used for the passage of wagons or vehicles of all kinds, for the transit of animals, and for foot-passengers, for such reasonable rate of toll as may be approved from time to time by the Secretary of War, or the same shall, at the option of said city of Salem, be a free bridge.

To be a lawful structure and post-route.
Postal telegraph.
Secretary of War to approve plans, etc.

SEC. 3. That the bridge authorized to be constructed under this act shall be a lawful structure, and shall be recognized and known as a post-route, and it shall enjoy the rights and privileges of other post-roads in the United States, upon which also no higher charge shall be made for transmission over the same of the mails, the troops, and the munitions of war of the United States, or for through passengers or freight passing over said bridge, than the rate per mile for their transportation over any railroad leading to the said bridge; and the United States shall have the right of way for a postal telegraph across said bridge. Said bridge shall be built and located under and subject to such regulations for the security of navigation of navigable rivers as the Secretary of War shall prescribe; and to secure that object the said city of Salem shall submit to the Secretary of War, for his examination and approval, a design and drawing of such bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-line at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed and channel of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plans and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of such bridge during the progress of construction thereof, such change shall be subject to the approval of the Secretary of War.

Changes.
May be transferred to Marion and Polk Counties.
Right to amend, etc., reserved.

SEC. 4. That such alterations or changes as may be required by the Secretary of War or Congress in the bridge constructed under the provisions of this act shall be made by the said city of Salem at its own expense; and at any time after the completion of such bridge the said city of Salem may, at its option, surrender and transfer to the counties of Marion and Polk, in the State of Oregon, the said bridge, and the entire control and management thereof, in which event, and in case of the acceptance thereof by said counties of Marion and Polk, they shall thenceforth be subject to all the obligations and conditions imposed on the city of Salem by the provisions of this act. And it is hereby expressly provided that Congress reserves the right at any time to alter, amend, or repeal this act.

Approved, July 29, 1886.

July 29, 1886.

CHAP. 806.—An act granting to the Oregonian Railway Bridge Company of Oregon the right to construct a bridge over the Willamette River in the vicinity of Ray's Landing, Oregon.

Oregonian Railway Bridge Company authorized to bridge the Willamette River, at Ray's Landing, Oregon.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Oregonian Railway Bridge Company, a corporation duly organized under the laws of Oregon, be authorized and permitted to build a railroad bridge across the Willamette River south of Oregon City, at such point as it may select in the vicinity of Ray's Landing, within the State of Oregon.

Construction.

Provisos.

Spans.

Draw.

Opening draw.

Lights, etc.

Wagon and foot bridge.

Tolls.

SEC. 2. That the bridge built under the provisions of this act may, at the option of said bridge company, be built as a draw-bridge or with unbroken and continuous spans: *Provided,* That if such bridge shall be made with unbroken and continuous spans, the main span shall be over the main channel of such navigable river, and shall be of such width, and the lowest part of the superstructure shall be of such height above extreme high-water mark, as the Secretary of War may prescribe, and such bridge shall be at right angles to and its piers parallel with the current or channel of the river over which it may be constructed; and if the bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed with an opening over the center of the channel of the river, and shall be of such width, character, and construction as the Secretary of War shall prescribe, and the piers of said bridge shall be parallel with the current, and the draws of said bridge shall be over the main or deep channel of the river, as may be fixed and determined by the Secretary of War: *Provided also,* That said draw shall be opened promptly upon reasonable signal for the passage of boats, and in no case shall unnecessary delay occur; and said company or corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe: *Provided also,* That said bridge, at the option of the corporation or company by which it may be built, may be used for the passage of wagons or vehicles of all kinds, for the transit of animals, and for foot-passengers, for such reasonable rate of toll as may be approved from time to time by the Secretary of War.

To be a lawful structure and post-route.

Postal telegraph.

Secretary of War to approve plans, etc.

SEC. 3. That the bridge authorized to be constructed under this act shall be a lawful structure, and shall be recognized and known as a post-route, and it shall enjoy the rights and privileges of other post-roads in the United States, upon which also no higher charge shall be made for transmission over the same of the mails, the troops, and the munitions of war of the United States, or for through passengers or freight passing over said bridge, than the rate per mile for their transportation over the railroads leading to the said bridge; and the United States shall have the right of way for a postal telegraph across said bridge. Said bridge shall be built and located under and subject to such regulations for the security and navigation of navigable rivers as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of such bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed and channel of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plans and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of such bridge during the progress of construction thereof, such change shall be subject to the approval of the Secretary of War.

Other companies to have right of way.

Secretary of War to decide erms.

SEC. 4. That all railroad companies desiring the use of the bridge constructed under this act, shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

SEC. 5. That the right to alter or amend this act so as to prevent or remove all material obstructions to the navigation of said river is hereby expressly reserved; and all changes or alterations so required shall be made at the expense of the parties owning or controlling said bridge.

Right to amend, etc., reserved.

Changes.

Approved, July 29, 1886.

CHAP. 807.—An act to authorize the construction of bridges across the Tennessee and Cumberland Rivers by the Ohio Valley Railway Company.

July 29, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Ohio Valley Railway Company, organized under act of the general assembly of the commonwealth of Kentucky, be, and is hereby, authorized to construct and maintain bridges, and approaches thereto, over the Tennessee River at any point below Aurora, in the State of Kentucky, and the Cumberland River at any point below Canton, on said river. Said bridges shall be constructed to provide for the passage of railway trains, and, at the option of the corporation by which they may be built, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot-passengers.

Ohio Valley Railroad Company authorized to bridge Tennessee and Cumberland Rivers.

Railway, wagon, and foot bridges.

SEC. 2. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, and it shall enjoy the rights and privileges of other post-roads in the United States.

To be lawful structures and post-routes.

SEC. 3. That all railroad companies desiring the use of said bridges shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon the payment of a reasonable compensation for such use; and in case the owner or owners of said bridges and the several railroad companies, or any of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridges, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

Other companies to have right of way.

Secretary of War to decide terms.

SEC. 4. That any bridges authorized to be constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said rivers as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridges, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the rivers, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridges are approved by the Secretary of War the bridges shall not be built, and should any change be made in the plan of said bridges during the progress of construction, such changes shall be subject to the approval of the Secretary of War.

Secretary of War to approve plans, etc.

SEC. 5. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Right to amend, etc., reserved.

SEC. 6. It is hereby provided that the bridges authorized to be constructed by this act shall be commenced within twelve month's and completed within three years from the passage of this act.

Commencement and completion.

Approved, July 29, 1886.

CHAP. 809.—An act granting to the county of Clatsop, in the State of Oregon, the right to construct a bridge across Young's Bay, a navigable stream in said county and State.

July 29, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the county of Clatsop, in the State of Oregon, is hereby authorized and empowered to construct a bridge across Young's Bay, a navigable stream in said county and State, at such point as said county may select and may be approved by the Secretary of War, with such channel spans, draws, safe-guards and auxiliary works as shall cause the bridge not unduly to obstruct or in-

Clatsop County, Oregon, authorized to bridge Young's Bay, under approval of Secretary of War.

Skipanon Creek.
Proviso.
Opening draws.
Lights, etc.

jure the navigation of the waters crossed by it; and that said channel-spans and structures shall be as the Secretary of War may prescribe; and also to construct, establish, and maintain a bridge across Skipanon Creek, in the county of Clatsop, in the State of Oregon, by permanent embankment or otherwise, as the Secretary of War may approve: *Provided also*, The said draws shall be opened promptly upon reasonable signal for the passage of ships and boats, and in no case shall unnecessary delay occur; and said county shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridges as the Light-House Board shall prescribe.

To be a lawful structure and post-route.
Telegraph.
Secretary of War to approve plans, etc.

SEC. 2. That any bridge authorized to be constructed under this act shall be a lawful structure, and shall be recognized as a post-route; and it shall enjoy the rights and privileges of other post-routes in the United States, upon which also no higher charge shall be made for transmission over the same of the mails, the troops, and the munitions of war of the United States, or for through passenger or freight passing over said bridge, than the rate per mile for their transportation over any railroad or other routes leading to said bridge, or over said stream in the vicinity; and the United States shall have the right of way for a telegraph across said bridges; the said bridges to be built and located under and subject to such regulations for the security of navigation on said bay and creek as the Secretary of War shall prescribe; and to secure that object the said county, by its proper court and duly authorized officers or agents, shall submit to the Secretary of War, for his examination and approval, a design and drawing of such bridge across Young's Bay, and a map of Young's Bay from the mouths of its navigable tributaries to the adjacent ship-channel, which map shall be on a scale of at least one to twenty thousand, and whose topography of the shores and hydrography shall reasonably represent the banks, the bottom, and steamboat channels by contours of six feet, and which shall be accompanied by other maps, drawn to a scale of one inch to two hundred feet, giving, within areas of one-fourth of a mile from each draw-span, an accurate representation of the bottom of the bay by contour-lines two feet apart, determined by accurate soundings, and also showing the force and direction of the currents at each two feet of tidal stage, by triangulated observations on suitable floats; also showing the Skipanon Creek to the head of usual navigation. The maps shall also show the locations of other bridges in the vicinity, and shall give such other information as the Secretary of War may require for a full and satisfactory understanding of the subject.

Right to amend, etc., reserved.
Changes.

SEC. 3. That Congress shall have power, at any time, to alter or amend this act so as to prevent or remove all material and substantial obstruction to the navigation of said bay and said creek by the construction of said bridges and accessory works; and the expense of altering said bridges or removing such obstructions shall be borne by the owner of said bridges.

Approved, July 29, 1886.

July 29, 1886.

CHAP. 811.—An act to give the assent of Congress to the construction of a bridge by the municipalities of Menominee, Michigan, and Marinette, Wisconsin, over Menominee River.

Menominee, Mich., and Marinette, Wis., authorized to bridge the Menominee River.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the assent of Congress is hereby given to the municipalities of Menominee, in the State of Michigan, and Marinette, in the State of Wisconsin, to construct and maintain a bridge, and approaches thereto, over the Menominee River, between the States of Michigan and Wisconsin, at a point to be determined by said municipalities, not to exceed one and one-fourth miles from the mouth of said river.

To be a lawful structure and post-route.
Postal telegraph.

SEC. 2. That any bridge built under the provisions of this act and subject to its limitations shall be a lawful structure and recognized and known as a post-route, and it shall enjoy the rights and privileges of other post-roads in the United States: *Provided*, That the United States may construct a postal telegraph over said bridge without charge therefor.

Spans.

SEC. 3. That if said bridge shall be built with unbroken and continuous spans, the spans thereof shall be of such width and height above the water as may be prescribed by the Secretary of War, and the main span shall be over the main channel of the river, and the bridge shall be at right angles to and its piers parallel with the current of the river: *Provided*, That if the same shall be constructed as a draw-bridge, the draw or pivot shall be over the main channel at an accessible point, and the spans shall be of such width and height above the water as may be prescribed by the Secretary of War, and the piers of said bridge shall be parallel with and the bridge itself at right angles to the current of the river: *Provided also*, That the said draw shall be opened promptly by said municipalities upon reasonable signal for the passage of boats; that sheer-booms shall be constructed by said municipalities; and that said municipalities shall maintain, at their own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe. No bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of such bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of said corporation; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the circuit court of the United States for the western district of Michigan or the eastern district of Wisconsin, in which any portion of said obstruction or bridge may be located: *Provided further*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt the bridge herein authorized to be constructed from the operations of the same.

Provisos.
Draw.
Opening draw.
Lights, etc.
Free navigation not to be impaired.
Litigation.
Laws to protect navigation not repealed.

SEC. 4. That any bridge authorized to be constructed under the provisions of this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said municipalities shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for a space of one mile above the proposed location, and below said location to the shore of Green Bay, at the mouth of said river, the topography of the banks of the river, the shore-lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War.

Secretary of War to approve plans, etc.

SEC. 5. That the right to alter, amend, or repeal this act is hereby expressly reserved, and the right to require any changes in said structure, or its entire removal, at the expense of the owners thereof, whenever Congress shall decide that the public interest requires it, is also expressly reserved.

Right to amend etc., reserved.

Approved, July 29, 1886.

CHAP. 827.—An act making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, and for other purposes.

July 31, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, in full compensation for the service of the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, for the objects hereinafter expressed, namely:

Legislative, executive, and judicial expenses appropriations.

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IN THE OFFICE OF THE CHIEF OF ENGINEERS.—One chief clerk, at two thousand dollars; four clerks of class four; two clerks of class three; three clerks of class two; three clerks of class one; one clerk, at one

Office of Chief of Engineers.

thousand dollars; one assistant messenger; and two laborers; in all, twenty-three thousand two hundred and forty dollars.

Draughtsmen, etc.

And the services of skilled draughtsmen, civil engineers, and such other services as the Secretary of War may deem necessary may be employed in the Office of the Chief of Engineers to carry into effect the various appropriations for rivers and harbors, fortifications, and surveys for military defenses, to be paid for from such appropriations: *Provided*, That the expenditures on this account for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, shall not exceed sixty thousand dollars; and that the Secretary of War shall each year, in the annual estimates, report to Congress the number of persons so employed, and the amount paid to each.

Proviso. Limitation.

Report.

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Rent.

For rent of buildings for use of the War Department, as follows:

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for the Chief of Engineers' Office, one thousand two hundred dollars;

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Public buildings and grounds.

PUBLIC BUILDINGS AND GROUNDS.

Clerk, messenger.

For clerk in the Office of Public Buildings and Grounds, one thousand six hundred dollars; and for messenger in the same office, eight hundred and forty dollars.

Gardener.

For the public gardener, one thousand eight hundred dollars.

Overseers, etc.

For overseers, draughtsman, foremen, mechanics, and laborers employed in the public grounds, twenty-eight thousand dollars.

Watchmen.

For watchman in Franklin Square, six hundred and sixty dollars.

For watchman in Lafayette Square, six hundred and sixty dollars.

For two day-watchmen in Smithsonian Grounds, at six hundred and sixty dollars each, one thousand three hundred and twenty dollars.

For two night-watchmen in Smithsonian Grounds, at seven hundred and twenty dollars each, one thousand four hundred and forty dollars.

For one watchman for Judiciary Square, and one for Lincoln Square and adjacent reservations, at six hundred and sixty dollars each, one thousand three hundred and twenty dollars.

For one watchman for Iowa Circle; one watchman for Thomas Circle and neighboring reservations; one for Rawlins Square and Washington Circle; one for Dupont Circle and neighboring reservations; one for McPherson and Farragut Squares; one for Stanton Place and neighboring reservations; two for Armory Square and reservations east to Botanic Garden; one for Mount Vernon Square and adjacent reservations; one for greenhouse at the nursery; one for grounds south of Executive Mansion, eleven in all, at six hundred and sixty dollars each, seven thousand two hundred and sixty dollars.

For one night-watchman for Armory Square and reservations east to Botanic Garden, at seven hundred and twenty dollars.

Contingent expenses.

For contingent and incidental expenses, five hundred dollars.

Rent.

For rent of office, nine hundred dollars.

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Approved, July 31, 1886.

August 2, 1886.

CHAP. 843.—An act to authorize the Secretary of War to permit the Carrollton and Lock Number One Turnpike Road Company to locate and construct its road on land belonging to the United States at Lock Number One, on the Kentucky River, in the State of Kentucky.

Right of way to Carrollton and Lock No. 1 Turnpike Road Company, through United States land at Lock No. 1, Kentucky River, Ky.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and is hereby, authorized and empowered to permit the Carrollton and Lock Number One Turnpike Road Company to locate and construct its road through the land belonging to the United States at Lock Number One, on the Kentucky River, in the State of Kentucky, upon such terms and conditions as he may consider proper: *Provided*, That said road shall not be so located or constructed as to obstruct the use of the said land by the United States for public purposes.

Proviso. Location.

Approved, August 2, 1886.

August 4, 1886.

CHAP. 902.—An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, and for other purposes.

Sundry civil appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated for the objects hereinafter expressed for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven, namely:

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Yellowstone Park, construction of roads and bridges.

PROTECTION AND IMPROVEMENT OF THE YELLOWSTONE NATIONAL PARK: For the construction and improvement of suitable roads and bridges within the park, under the supervision and direction of an engineer officer detailed by the Secretary of War for that purpose, twenty thousand dollars.

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BUILDINGS AND GROUNDS IN AND AROUND WASHINGTON.

Buildings and grounds, Washington, D. C.

Improvement, care, etc.

For the improvement and care of public grounds as follows:

For improvement and maintenance of grounds south of the Executive Mansion, six thousand dollars.

For ordinary care of greenhouses and nursery, two thousand dollars.

For ordinary care of Lafayette Square, one thousand dollars.

For ordinary care of Franklin Square, one thousand dollars.

For care and improvement of reservation numbered three (Monument Grounds), one thousand dollars.

For continuing improvement of reservation numbered seventeen, and site of old canal, northwest of same, ten thousand dollars: *Provided,* That no part thereof shall be expended upon other than property belonging to the United States.

For manure, and hauling same, five thousand dollars.

For painting iron fences, vases, lamps, and lamp-posts, one thousand dollars.

For purchase and repair of seats, one thousand dollars.

For purchase and repair of tools, two thousand dollars.

For trees, tree-stakes, lime, white-washing, and stock for nursery, three thousand dollars.

For removing snow and ice, one thousand two hundred dollars.

For flower-pots, twine, baskets, and lycopodium, one thousand dollars.

For care, construction, and repair of fountains in the public grounds, one thousand five hundred dollars.

For abating nuisances, five hundred dollars.

For improvement, care, and maintenance of various reservations, twelve thousand dollars.

For improvement maintenance, and care of Smithsonian Grounds, ten thousand dollars.

For improving grounds around the Pension Building, Judiciary Square, five thousand dollars.

Limit of cost of concrete pavements.

That under appropriations herein contained no contract shall be made for making or repairing concrete or asphalt pavements in Washington City at a higher price than two dollars per square yard for a quality equal to the best heretofore laid in the District of Columbia.

Executive Mansion.

Repairs, fuel, etc.

For repairs and fuel at the Executive Mansion as follows:

For care, repair, and refurnishing the Executive Mansion, sixteen thousand dollars to be expended by contract or otherwise as the President may determine.

For fuel for the Executive Mansion and greenhouses, three thousand dollars.

For care and necessary repair of greenhouses, four thousand dollars.

For repair of conservatory of Executive Mansion, six thousand dollars.

Lighting Executive Mansion and public grounds.

LIGHTING THE EXECUTIVE MANSION AND PUBLIC GROUNDS, For gas, pay of lamp-lighters, gas-fitters and plumbers; gas-fitting and plumbing; purchase and erection of lamps and lamp-posts; purchase of matches, and for repairs of all kinds; fuel and lights for office, stables, watchmen's lodges, and for the greenhouses at the nursery, fourteen thousand dollars: *Provided,* That for each six-foot burner not connected with a meter in the lamps on the public grounds no more than twenty dollars shall be paid per lamp for gas, including lighting, clean-

Proviso.

Maximum payment per lamp.

ing, and keeping in repair the lamps, under any expenditure provided for in this act; and authority is hereby given to substitute other illuminating material for the same or less price, and to use so much of the sum hereby appropriated as may be necessary for that purpose.

Water-pipes and fire-plugs.
Repairs, etc.

REPAIR OF WATER-PIPES AND FIRE-PLUGS—For repairing and extending water-pipes, purchase of apparatus to clean them, and cleaning the springs and repairing and renewing the pipes of the same that supply the Capitol, the Executive Mansion and the building for the State, War, and Navy Departments, two thousand five hundred dollars.

Government telegraph.

TELEGRAPH TO CONNECT THE CAPITOL WITH THE DEPARTMENTS AND GOVERNMENT PRINTING OFFICE: For care and repair of existing lines, one thousand two hundred and fifty dollars.

Building for State, War, and Navy Departments.
Completion.

BUILDING FOR THE STATE, WAR, AND NAVY DEPARTMENTS: For completing the construction of the building, roofs, heating apparatus, elevators, partitions, iron work, doors, plastering and stucco-work, plumbing and gas-fitting, approaches, and for each and every purpose connected with the construction of the building, including the rent of necessary office-room, five hundred thousand dollars.

Washington Monument.
Completion.
Vol. 21, p. 123.
Proviso.
Filling pond.

WASHINGTON MONUMENT: For completion of the Washington Monument, namely: For earth-filling and grading around the monument, filling so much of the pond just north of Monument as may be needful to secure the foundation of the monument, office expenses, including rent of necessary office-rooms, and for each and every purpose connected with the completion of the monument, fifty-seven thousand dollars, to be expended under the direction of the joint commission created by the act of August second, eighteen hundred and seventy-six: *Provided,* That the work of filling the pond north of the monument shall not be commenced before December first, eighteen hundred and eighty-six.

Medical Museum.

BUILDING FOR ARMY MEDICAL MUSEUM AND LIBRARY: For stacks of book-cases in library hall, including iron supports, stairs, and perforated gallery-floors, twenty thousand dollars.

Cases, shelving, etc.

For shelving and cases for record and pension division two thousand dollars.

For cases for museum, ten thousand dollars.

For shelving and cases for center building, two thousand dollars.

For carpets and furniture, three thousand dollars.

For gas-fixtures for entire building, one thousand and fifty dollars.

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Fort Monroe, Va.
Construction of wharf.

WHARF AT FORT MONROE, VIRGINIA: In full for the construction and completion of a new wharf, and improvements to the roadway leading thereto, on the Government reservation at Fortress Monroe, Virginia, upon plans to be approved by the Secretary of War, one hundred thousand dollars, or so much thereof as may be necessary for the purpose.

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Survey of northern and northwestern lakes.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES: For printing and issuing charts for use of navigators, and electrotyping copper-plates for chart-printing; two thousand dollars.

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Approved, August 4, 1886.

August 4, 1886.

CHAP. 903.—An act making appropriations to supply deficiencies in the appropriations for the fiscal year ending June thirtieth, eighteen hundred and eighty-six, and for prior years, and for other purposes.

Deficiency appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, to supply deficiencies in the appropriations for the fiscal year eighteen hundred and eighty-six, and for other objects hereinafter stated, namely:

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Increase of water supply.
Vol. 22, p. 168.

INCREASE OF WATER SUPPLY, WASHINGTON, DISTRICT OF COLUMBIA: To enable the Secretary of War to complete the work of increasing the water supply of the city of Washington under the act entitled "An act to increase the water supply of the city of Washington, and for other purposes," approved July fifteenth, eighteen hundred and eighty-two, namely: To complete the reservoir, one hundred and sixty thousand dollars; to complete the tunnel, three hundred and ninety-five thousand dollars; in all, five hundred and fifty-five thousand dollars, or so much thereof as may be necessary; but the Secretary of War is instructed forthwith, to submit to the Board of Engineers for Fortifications and for River and Harbor Improvements whether any changes are demanded for reasons of safety or economy in the method of lining said tunnel heretofore adopted and pursued, and whether any changes are required in the method of lining and perfecting the reservoir: *Provided*, That said board shall make full report thereon and pending such examination the work shall proceed upon such parts thereof as the Secretary of War shall direct. The work above provided for to be done under the contract heretofore made or by a reletting, as in the discretion of the Secretary of War shall be most promotive of the interest of the Government, and the two sums hereinabove appropriated to be subject to all the provisions and restrictions of the said act of July fifteenth, eighteen hundred and eighty-two, and of the act approved July fifth, eighteen hundred and eighty-four, making appropriations for the expenses of the government of the District of Columbia, as to its apportionment and settlement between the United States and the District of Columbia and the refunding thereof.

To complete reservoir and tunnel.

Board of Engineers to report whether changes are required.

Proviso.

Work to proceed pending report.

Apportionment between United States and District.

Vol. 22, p. 170.

Vol. 23, p. 132.

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PUBLIC BUILDINGS AND GROUNDS UNDER CHIEF ENGINEER.

To pay outstanding liability contracted by Colonel A. F. Rockwell, while in charge of public buildings and grounds, under the Chief of Engineers, for putting down and taking up crash, and so forth, at receptions at the Executive Mansion, between January thirteenth and February twenty-first, eighteen hundred and eighty-five, being for the service of the fiscal year eighteen hundred and eighty-five, one hundred and thirty-five dollars and fifty cents.

Public buildings and grounds.

Executive Mansion.

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CLAIMS ALLOWED BY THE THIRD AUDITOR AND SECOND COMPTROLLER.

Claims allowed by Third Auditor and Second Comptroller.

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WAR DEPARTMENT.

War Department.

For contingencies of fortifications, eighteen hundred and sixty-four and prior years, two thousand three hundred and thirty-nine dollars and forty-two cents.

Fortifications, contingencies.

For surveys for military defenses, eighteen hundred and eighty-three and prior years, twelve dollars.

Military defenses, surveys.

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WAR DEPARTMENT CLAIMS ALLOWED BY THE THIRD AUDITOR AND SECOND COMPTROLLER.

Claims allowed by Third Auditor and Second Comptroller, War Department.

For contingencies of fortifications, seventy-one dollars and seventeen cents.

Fortifications.

For improving Umpqua River, Oregon, one dollar and forty-seven cents.

Umpqua River, Oregon.

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Approved, August 4, 1886.

CHAP. 929. An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

August 5, 1886.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, and to be expended under the direction of the Secretary of War, for the construction, completion, repair, and preservation of the public works herein named:

River and harbor appropriations.

Harbors.

Rockland, Me. Improving harbor at Rockland, Maine: Continuing improvement, twenty-two thousand five hundred dollars.

Saco River, breakwater, Me. Improving breakwater at the mouth of Saco River, Maine: Continuing improvement and repairs, twelve thousand five hundred dollars.

Portland, Me. Improving harbor at Portland, Maine: Continuing improvement, thirty thousand dollars.

Back Cove, channel, Me. Improving the channel in Back Cove, Portland, Maine: Continuing improvement, twenty-six thousand two hundred and fifty dollars.

York, Me. Improving harbor at York, Maine, fifteen thousand dollars.

Portsmouth, N. H. Improving harbor at Portsmouth, New Hampshire: Continuing improvement, fifteen thousand dollars.

Little Harbor, N. H. Improving the harbor of refuge at Little Harbor, New Hampshire: Continuing improvement, ten thousand dollars.

Burlington, Vt. Improving harbor at Burlington, Vermont: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Gordon's Landing breakwater, Lake Champlain. For a breakwater at Gordon's Landing, on Lake Champlain, to be built on the twelve foot curve mentioned in the papers accompanying the report of the Secretary of War to the Senate dated March first, eighteen hundred and eighty-six (Executive Document Number Eighty-one, Forty-ninth Congress, first session), eighteen thousand seven hundred and fifty dollars.

Boston, Mass. Improving harbor at Boston, Massachusetts: Continuing improvement, fifty-six thousand two hundred and fifty dollars; of which eigteen thousand seven hundred and fifty dollars are to be expended at Fort Port Channel, on Part A, below Congress Street Bridge.

Lynn, Mass. Improving harbor at Lynn, Massachusetts: Continuing improvement, six thousand dollars.

Nantucket, Mass. Improving harbor at Nantucket, Massachusetts: Continuing improvement, fifteen thousand dollars.

Hannis Harbor Mass. Improving Hyannis Harbor, Massachusetts, ten thousand dollars.

Newburyport, Mass. Improving harbor at Newburyport, Massachusetts: Continuing improvement, thirty-seven thousand five hundred dollars.

Wareham, Mass. Improving harbor at Wareham, Massachusetts: Continuing improvement, fifteen thousand dollars.

Plymouth, Mass. Improving harbor at Plymouth, Massachusetts: Continuing improvement, six thousand dollars.

Hingham, Mass. Improving harbor at Hingham, Massachusetts: Continuing improvement, six thousand dollars.

Provincetown, Mass. Improving harbor at Provincetown, Massachusetts: Continuing improvement, three thousand dollars.

Gloucester, Mass. Improving harbor at Gloucester, Massachusetts, five thousand dollars; of which two thousand dollars, or so much as may be needed for a survey, and remainder on Babson's Ledge.

Sandy Bay, harbor, of refuge. For the national harbor of refuge of the first class at Sandy Bay: Continuing improvement, one hundred thousand dollars.

Scituate, Mass. Improving harbor at Scituate, Massachusetts: Continuing improvement, ten thousand dollars.

Westport, Mass. Improving harbor at Westport, Massachusetts: Continuing improvement, one thousand dollars, for sand-fence.

Wood's Holl, Mass. Improving harbor at Wood's Holl, Massachusetts: Continuing improvement, fourteen thousand five hundred dollars.

Block Island, R. I. Improving harbor at Block Island, Rhode Island: Continuing improvement, twenty thousand dollars; of which eight thousand dollars shall be expended on the breakwater and twelve thousand dollars on the inner harbor.

Newport, R. I. Improving harbor at Newport, Rhode Island: Continuing improvement, fifteen thousand dollars.

Bridgeport, Conn. Improving harbor at Bridgeport, Connecticut: Continuing improvement, twenty thousand dollars.

Black Rock, Conn. Improving harbor at Black Rock, Connecticut: Continuing improvement, five thousand dollars.

New Haven Conn. Improving breakwater at New Haven, Connecticut: Continuing improvement, seventy-five thousand dollars.

Improving harbor at New Haven, Connecticut: Continuing improvement, twenty thousand dollars.

New London, Conn. Improving harbor at New London, Connecticut: Continuing improvement, two thousand dollars.

Norwalk, Conn. Improving harbor at Norwalk, Connecticut: Continuing improvement, three thousand dollars.

Stonington, Conn.

Improving harbor at Stonington, Connecticut: Continuing improvement, twenty thousand dollars.

Stamford, Conn.

Improving harbor at Stamford, Connecticut: Continuing improvement, ten thousand dollars.

Buffalo, N. Y.

Improving harbor at Buffalo, New York: Continuing improvement, and repairs on the outer breakwater, one hundred and twelve thousand five hundred dollars.

Buttermilk Channel, N. Y.

Improving Buttermilk channel, New York: Continuing improvement, fifty six thousand two hundred and fifty dollars.

Rouse's Point, N. Y.

Improving breakwater at Rouse's Point, New York: Continuing improvement, twenty thousand dollars.

Dunkirk, N. Y.

Improving harbor at Dunkirk, New York: Continuing improvement, twenty thousand dollars.

Canarsie Bay, N. Y.

Improving harbor at Canarsie Bay, New York: Continuing improvement, ten thousand dollars.

Charlotte, N. Y.

Improving harbor at Charlotte, New York: Continuing improvement and repairs, twenty-six thousand two hundred and fifty dollars.

Flushing Bay, N. Y.

Improving harbor at Flushing Bay, New York: Continuing improvement, ten thousand dollars.

Gowanus Bay, N. Y.

Improving channel at Gowanus Bay, New York: Continuing improvement, seven thousand five hundred dollars.

Great Sodus Bay, N. Y.

Improving harbor at Great Sodus Bay, New York: Continuing improvement, sixteen thousand eight hundred and seventy-five dollars.

Greenport, N. Y.

Improving harbor at Greenport, New York: Continuing improvement, five thousand dollars.

Little Sodus Bay, N. Y.

Improving harbor at Little Sodus Bay, New York: Continuing improvement, twelve thousand five hundred dollars.

Oak Orchard, N. Y.

Improving harbor at Oak Orchard, New York: Continuing improvement by repairs, twelve thousand five hundred dollars.

Olcott, N. Y.

Improving harbor at Olcott, New York: Continuing improvement and repairs, ten thousand dollars.

Wilson, N. Y.

Improving harbor at Wilson, New York: Continuing improvement, ten thousand dollars.

Ogdensburg, N. Y.

Improving harbor at Ogdensburg, New York: Continuing improvement, ten thousand dollars; which, together with the amount on hand, is to be used in removing obstructions from the mouth of the Oswegatchee and continuing the excavation at the lower harbor up stream.

Oswego, N. Y.

Improving harbor at Oswego, New York: Continuing improvement, seventy-one thousand two hundred and fifty dollars; of which fifty-six thousand two hundred and fifty dollars to be used in repairs and fifteen thousand dollars in continuing work on the harbor.

Rondout, N. Y.

Improving harbor at Rondout, New York: Continuing improvement, two thousand five hundred dollars.

Saugerties, N. Y.

Improving harbor at Saugerties, New York: Continuing improvements, fifteen thousand dollars.

Sheepshead Bay, N. Y.

Improving harbor at Sheepshead Bay, New York: Continuing improvement, five thousand dollars.

New York.

Improving New York Harbor, New York: To secure a thirty-foot channel at mean low water at Sandy Hook entrance of the harbor, upon such plan as the Secretary of War may approve, seven hundred and fifty thousand dollars.

Channel, Staten Island and New Jersey.

Improving channel between Staten Island and the New Jersey shore, New York and New Jersey: Continuing improvement, fifteen thousand dollars.

Raritan Bay, N. J.

Improving harbor at Raritan Bay, New Jersey: Continuing improvement, thirty-seven thousand five hundred dollars.

Plattsburg, N. Y.

Improving harbor at Plattsburg, New York: Continuing improvement, five thousand dollars.

Atlantic City, survey for harbor of refuge.

For a more thorough and definite survey and examination of the harbor at Atlantic City, New Jersey, with a view to making a harbor of refuge at that point, five thousand dollars; said examination and survey to be made by a board consisting of three United States engineers.

Erie, Pa.

Improving harbor at Erie, Pennsylvania: Continuing improvement, and also for the improvement of said harbor as recommended by the Chief of Engineers, January thirteenth, eighteen hundred and eighty-five, thirty-seven thousand five hundred dollars: *Provided*, That the Secretary of War be, and he is hereby, authorized and directed to receive and accept for the United States, from the marine hospital of

Proviso.

Title to Presque Isle to be accepted by Secretary of War.

Erie, Pennsylvania, the title to the peninsula of Presque Isle, at Erie, Pennsylvania, as tendered by the said marine hospital, agreeably to the provisions of an act of the legislature of the State of Pennsylvania, approved May eleventh, eighteen hundred and seventy-one: *And provided further*, That twenty-two thousand five hundred dollars of said sum shall not be expended until the aforesaid title shall be accepted by the Secretary of War.

Marcus Hook, Pa., ice-harbor.

Improving ice-harbor at Marcus Hook, Pennsylvania: Continuing improvement, fifteen thousand dollars.

Chester, Pa., cession of piers to.

The Secretary of war is authorized to cede to the city of Chester, Pennsylvania, the upper and lower piers located in said city and extending into the Delaware River, and formerly used as an ice harbor.

Delaware breakwater.

Improving Delaware breakwater, Delaware: Continuing improvement, fifty-six thousand two hundred and fifty dollars.

New Castle, Del., ice-harbor.

Improving ice-harbor at New Castle, Delaware: Continuing improvement, five thousand dollars.

Wilmington, Del.

Improving harbor at Wilmington, Delaware: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Baltimore, Md.

Improving harbor at Baltimore, Maryland: Continuing improvement, one hundred and fifty thousand dollars.

Breton Bay, Md.

Improving harbor at Breton Bay, Maryland: Continuing improvement, six thousand five hundred dollars

Washington, D. C., Potomac River.

For continuing the improvement of the Potomac River in the vicinity of Washington, with reference to the improvement of navigation, the establishment of harbor-lines, and the raising of the flats, under the direction of the Secretary of War and in accordance with existing plans, three hundred and seventy-five thousand dollars: *Provided*, That no part of the sum hereby appropriated shall be expended upon or with reference to any place in respect of which the title of the United States is in doubt, or in respect to which any claim adverse to the United States has been made.

Proviso.
Not to be expended where title is doubtful.

Norfolk, Va., approach to harbor and navy-yard.

Improving harbor at Norfolk, Virginia, and improving approach to Norfolk Harbor and the United States navy-yard at Norfolk: Continuing improvement by widening the channel of Elizabeth River to the port-warden's line on the eastern side, between Lambert's Point Light and Fort Norfolk, one hundred and eighty-seven thousand five hundred dollars; of which fifty thousand dollars shall be expended in improving the harbor, and one hundred and thirty-seven thousand five hundred dollars in widening the channel of Elizabeth River to the port-warden's line on the eastern side, between Lambert's Point Light and Fort Norfolk, beginning at Lambert's Point Light, including the construction of the proposed dike.

Beaufort, N. C.

Improving harbor at Beaufort, North Carolina: Continuing improvement, fifteen thousand dollars.

Edenton Bay, N. C.

Improving harbor at Edenton Bay, North Carolina: Continuing improvement, two thousand dollars.

Water way, New Berne and Beaufort, N. C.

Improving the inland water way between New Berne and Beaufort, North Carolina, ten thousand dollars.

Charleston, S. C.

Improving harbor at Charleston, including Sullivan's Island, South Carolina: Continuing improvement, one hundred and eighty-seven thousand five hundred dollars.

Winyaw Bay, S. C.

Improving Winyaw Bay, South Carolina: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Georgetown, S. C.

Improving harbor at Georgetown, South Carolina: Continuing improvement, five thousand dollars.

Brunswick, Ga.

Improving harbor at Brunswick, Georgia: Continuing improvement, twenty-two thousand five hundred dollars.

Cumberland Sound, Georgia and Florida.

Improving Cumberland Sound, Georgia and Florida: Continuing improvement, one hundred and twelve thousand five hundred dollars.

Savannah, Ga.

Improving harbor at Savannah, Georgia: Continuing improvement, one hundred and fifty thousand dollars.

Apalachicola Bay, Florida.

Improving harbor at Apalachicola Bay, Florida: Continuing improvement, twelve thousand dollars; of which two thousand dollars may, in the discretion of the Secretary of War, be expended at the Carabelle or Crooked River.

Key West, Fla., survey of entrance.

For examination and survey of the entrance to harbor at Key West, Florida, two thousand five hundred dollars.

Pensacola, Fla.

Improving harbor at Pensacola, Florida: Continuing improvement, twenty thousand dollars.

Tampa Bay, Fla.

Improving harbor at Tampa Bay, Florida: Continuing improvement, ten thousand dollars.

Cedar Keys. Fla.

Improving harbor at Cedar Keys, Florida, seven thousand dollars.

Mobile, Ala.

Improving harbor at Mobile, Alabama: Continuing improvement, ninety thousand dollars.

Biloxi, Miss.

Improving harbor at Biloxi Bay, Mississippi: Continuing improvement, twelve thousand five hundred dollars; which sum, together with the money on hand heretofore appropriated for the roadstead, is hereby directed to be used in deepening the channel from Mississippi Sound to the wharves at Biloxi.

Aransas Pass and Bay, Tex.

Improving Aransas Pass and Bay up to Rockport and Corpus Christi, Texas: Continuing improvement, one hundred and one thousand two hundred and fifty dollars.

Brazos Santiago, Tex.

Improving Brazos Santiago Harbor, Texas: Continuing improvement, thirty-seven thousand five hundred dollars.

Galveston, Tex.

Improvement of entrance to Galveston Harbor, Texas: Continuing improvement, three hundred thousand dollars.

Pass Cavallo, Tex.

Improving Pass Cavallo, Texas: Continuing improvement, thirty-seven thousand five hundred dollars.

Sabine Pass, Blue Buck Bar, Tex.

Improving Sabine Pass and Blue Buck Bar, Texas: Continuing improvement, one hundred and ninety-eight thousand seven hundred and fifty dollars.

Galveston Bay, ship-channel, Tex.

Improving ship-channel in Galveston Bay, Texas, from Morgan's Cut to Bolivar Channel: Continuing improvement, for which purpose the balance now remaining of the money heretofore appropriated for this work is hereby directed to be expended by the Secretary of War in the completion of said channel, in accordance with the plans heretofore adopted, and in marking out said channel by piles or stakes, so as to enable navigators to find the same without difficulty.

Ashtabula, Ohio.

Improving harbor at Ashtabula, Ohio: Continuing improvement, thirty thousand dollars.

Black River, Ohio.

Improving harbor at mouth of Black River, Ohio: Continuing improvement, ten thousand dollars.

Cleveland, Ohio.

Improving harbor at Cleveland, Ohio, on the last plan projected, ninety-three thousand seven hundred and fifty dollars; of which thirty thousand dollars are to be used in building a parapet on the existing breakwater, and the one hundred thousand dollars now on hand to be available for work on the last plan.

Fairport, Ohio.

Improving harbor at Fairport, Ohio: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Huron, Ohio.

Improving harbor at Huron, Ohio: Continuing improvement, three thousand dollars.

Muskingum River, Ohio.

Improving ice-harbor at the mouth of the Muskingum River, Ohio: Continuing improvement, thirty-seven thousand five hundred dollars.

Port Clinton, Ohio.

Improving harbor at Port Clinton, Ohio, by repairs of existing works, two thousand dollars.

Purchase of land at.

For the purpose of acquiring the title to the land adjoining the inner end of the west pier built by the United States for the improvement of the harbor at Port Clinton, Ohio, the Secretary of War shall negotiate with the owner or owners of the land for the purchase thereof at a reasonable price, to be approved by Congress; and if an agreement as to price cannot be made with the owner, then the value of the same shall be ascertained in the mode provided by the laws of Ohio for the condemnation of lands for public uses in that State, the result of said proceedings of condemnation, if taken, to be reported to the next Congress for its approval.

Sandusky, Ohio.

Improving harbor at Sandusky City, Ohio, by dredging the channel through the outer bar and within the bay; and for this purpose the money appropriated by act of July fifth, eighteen hundred and eighty-four, now on hand, is hereby made available, and the further sum of five thousand dollars is hereby appropriated.

Toledo, Ohio.

Improving harbor at Toledo, Ohio: Continuing improvement of the Maumee River, by a straight channel along such line as may be approved by the Secretary of War, one hundred and twelve thousand five hundred dollars; and the balance of the twenty-five thousand dollars heretofore appropriated are hereby made available for clearing the old channel.

Vermillion, Ohio.

Improving harbor at Vermillion, Ohio: Continuing improvement, three thousand dollars.

Michigan City, Ind.

Improving harbor at Michigan City, Indiana: Continuing improvement, fifty-six thousand two hundred and fifty dollars; of which sum one thousand eight hundred and seventy-five dollars are to be used on the inner harbor.

Calumet, Ill.
Improving harbor at Calumet, Illinois: Continuing improvement, ten thousand dollars.

Chicago, Ill.
Improving harbor at Chicago, Illinois: Continuing improvement, seventy-five thousand dollars.

Waukegan, Ill.
Improving harbor at Waukegan, Illinois: Continuing improvement, twenty thousand dollars.

Charlevoix, Mich.
Improving harbor at Charlevoix and entrance to Pine Lake, Michigan: Continuing improvement, ten thousand dollars.

Cheboygan, Mich.
Improving harbor at Cheboygan, Michigan: Continuing improvement, fifteen thousand dollars.

Frankfort, Mich.
Improving harbor at Frankfort, Michigan, by extension of piers and repairs: Continuing improvement, seven thousand dollars.

Grand Haven, Mich.
Improving harbor at Grand Haven, Michigan: Continuing improvement, thirty thousand dollars.

Grand Marais, Mich.
Improving harbor of refuge at Grand Marais, Michigan: Continuing improvement, twenty-six thousand two hundred and fifty dollars.

Ludington, Mich.
Improving harbor at Ludington, Michigan: Continuing improvement, fifty-six thousand two hundred and fifty dollars.

Manistee, Mich.
Improving harbor at Manistee, Michigan: Continuing improvement, ten thousand dollars.

Marquette, Mich.
Improving harbor at Marquette, Michigan: Continuing improvement, ten thousand dollars.

Monroe, Mich.
Improving harbor at Monroe, Michigan: By repairs, two thousand dollars.

Muskegon, Mich.
Improving harbor at Muskegon, Michigan: Continuing improvement, twelve thousand five hundred dollars.

Ontonagon, Mich.
Improving harbor at Ontonagon, Michigan: Continuing improvement, thirteen thousand dollars.

Pentwater, Mich.
Improving harbor at Pentwater, Michigan: Continuing improvement, ten thousand dollars.

Portage Lake, Mich.
Improving harbor at Portage Lake, Michigan: Continuing improvement, fifteen thousand dollars.

Sand Beach, Mich.
Improving and repairing harbor of refuge at Sand Beach, Michigan: Continuing improvement, seventy-five thousand dollars; of which not exceeding forty-five thousand dollars are to be used in repairs.

Saint Joseph, Mich.
Improving harbor at Saint Joseph, Michigan: Continuing improvement, ten thousand dollars.

Saugatuck, Mich.
Improving harbor at Saugatuck, Michigan: To complete improvement, eight thousand dollars.

South Haven, Mich.
Improving harbor at South Haven, Michigan: Continuing improvement, five thousand dollars.

White River, Mich.
Improving harbor at White River, Michigan: Continuing improvement, ten thousand dollars.

Black Lake, Mich.
Improving harbor at Black Lake, Michigan: Continuing improvement, five thousand dollars.

Ahnapee, Wis.
Wharfage to be free.
Improving harbor at Ahnapee, Wisconsin: Continuing improvement, fifteen thousand dollars; but no part of said sum is to be expended until the wharfage over the Government piers at that port shall be made free.

Green Bay, Wis.
Improving harbor at Green Bay, Wisconsin: Continuing improvement, seven thousand dollars.

Kenosha, Wis.
Improving harbor at Kenosha, Wisconsin: Continuing improvement, five thousand dollars.

Kewaunee, Wis.
Improving harbor at Kewaunee, Wisconsin: Continuing improvement, ten thousand dollars.

Manitowoc, Wis.
Improving harbor at Manitowoc, Wisconsin: Continuing improvement, fifteen thousand dollars.

Menomonee, Wis.
Improving harbor at Menomonee, Wisconsin: Continuing improvement, three thousand dollars.

Milwaukee, Wis.
Improving harbor of refuge at Milwaukee, Wisconsin: Continuing improvement on bay and harbor, sixty thousand dollars.

Oconto, Wis.
Improving harbor at Oconto, Wisconsin: Continuing improvement, eight thousand dollars.

Port Washington, Wis.
Improving harbor at Port Washington, Wisconsin: Continuing improvement, five thousand dollars.

Racine, Wis.
Improving harbor at Racine, Wisconsin: Continuing improvement, ten thousand dollars.

Superior and Saint Louis Bays, Wis.
Improving harbor at Superior Bay and Saint Louis Bay, Wisconsin: Continuing improvement, twenty-two thousand five hundred dollars;

and the engineer in charge, in his next annual report, shall submit an estimate of the cost of a dredge-boat or other facilities that may be needed for dredging the harbors of Duluth and Superior. Thirteen thousand five hundred dollars of the money hereby appropriated are to be expended in dredging in said Superior Bay and Harbor, and in repairing piers at natural entry, and nine thousand dollars in dredging Saint Louis Bay, along the dock-line on the Wisconsin shore, from deep water at Connor's Point towards deep water at Grassy Point.

Sheboygan, Wis.

Improving harbor at Sheboygan, Wisconsin: Continuing improvement, fifteen thousand dollars.

Sturgeon Bay, Wis.

Improving harbor at Sturgeon Bay, Wisconsin: Continuing improvement, five thousand dollars.

Ashland, Wis.

Improving harbor at Ashland, Wisconsin: Continuing improvement, twenty-two thousand five hundred dollars.

Sturgeon Bay and Lake Michigan Ship-Canal. Board of engineers to report as to its value, etc.

The Secretary of War is authorized and directed to appoint a Board of three engineers from the United States Army whose duty it shall be to examine, in all their relations to commerce, the Sturgeon Bay and Lake Michigan Ship-Canal, connecting the waters of Green Bay with Lake Michigan, in the State of Wisconsin, with a view to making the same a free passage way and harbor of refuge, to consider their value, and all other matters connected with their usefulness to navigation, and which shall give information as to the expediency of the work and the desirability of their acquisition and improvement. The said Board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon; and five thousand dollars, or so much thereof as may be necessary, is hereby appropriated for this purpose.

Duluth, Minn.

Improving harbor at Duluth, Minnesota: Continuing improvement, and enlarging basin between Minnesota and Rice's Points, fifty-six thousand two hundred and fifty dollars; of which a sum not exceeding five hundred dollars may be used in placing buoys in the channels and elsewhere where needed in the harbor; and the consent of the United States is hereby given to a change of the existing dock-line on the east side of Rice's Point by the municipal authorities of Duluth: *Provided*, That such change meets the approval of the Secretary of War.

Grand Marais, Minn.

Improving harbor at Grand Marais, Minnesota: Continuing improvement, ten thousand dollars.

Agate Bay, Minn.

Improving harbor at Agate Bay, Minnesota, twenty-two thousand five hundred dollars.

Lake City, Minn.

Improving harbor at Lake City, Minnesota, Continuing improvement, ten thousand dollars.

Humboldt, Cal. *Proviso.*

Improving harbor and bay at Humboldt, California: Continuing improvement, seventy-five thousand dollars: *Provided*, That no part of said sum shall be expended until the twelve acres of land necessary to said improvement shall have been conveyed to the United States free of expense, and such conveyance has been approved by the Secretary of War, after the Attorney-General of the United States shall have certified to the Secretary of War that the title is perfect.

Oakland, Cal.

Improving harbor at Oakland, California: Continuing improvement, sixty thousand dollars.

Survey of San Francisco Harbor, San Pablo Bay, Suisun Bay, Strait of Carquinex, San Joaquin and Sacramento Rivers.

The sum of eleven thousand dollars, or as much thereof as may be necessary, is hereby appropriated for a survey of San Francisco Harbor, San Pablo Bay, Suisun Bay, Strait of Carquinex, mouth of San Joaquin River, and mouth of Sacramento River, California.

Redwood, Cal.

Improving harbor at Red Wood, California: Continuing improvement, five thousand dollars.

Survey, etc., of San Diego, Newport and San Luis Obispo Harbors, Cal.

The sum of five thousand dollars, or so much thereof as may be necessary, is hereby appropriated for examination, survey, and estimated cost of obtaining a channel two hundred and fifty feet wide and twenty-four feet deep at mean low water across the outer bar, and from thence to a point abreast of beacon number two, in San Diego Harbor, California; also, of obtaining a navigable channel at least eight feet in depth at mean low water at Newport Harbor, California; also, of the establishment of a breakwater extending in a southeasterly direction one-fourth of a mile, more or less, along the sunken reef commencing at or near Whaler's Point, so called, at San Luis Obispo Harbor, California.

Wilmington, Cal. Improving harbor at Wilmington, California: Continuing improvement, seventy-five thousand dollars.

Yaquina Bay, Oreg. Improving harbor at Yoquina Bay, Oregon: Continuing improvement, seventy-five thousand dollars.

Coos Bay, Oreg. Improvement of the harbor at entrance of Coos Bay, Oregon, thirty-three thousand seven hundred and fifty dollars.

Lubec Channel. Improving Lubec Channel, Maine: Continuing improvement, ten thousand dollars.

Moosebec Bar. Improving Moosebec Bar, Maine: Continuing improvement, ten thousand dollars.

Penobscot River. Improving Penobscot River, Maine: Continuing improvement, by widening the channel opposite Bangor and removing obstructions near Crosby's Narrows, fifteen thousand dollars.

Saco River. Improving Saco River, Maine, twelve thousand five hundred dollars.

Narragaugus River. Improving Narragaugus River, Maine, ten thousand dollars.

Cocheco River. Improving Cocheco River, New Hampshire: Continuing improvement, ten thousand dollars.

Ipswich River. Improving Ipswich River, Massachusetts, two thousand five hundred dollars.

Warren River. Improving Warren River, Rhode Island, five thousand dollars.

Pawtucket River. Improving Pawtucket River, Rhode Island: Continuing improvement, thirty thousand dollars.

Providence River, Narragansett Bay. Improving Providence River and Narragansett Bay, Rhode Island: Continuing improvement, thirty thousand dollars

Providence River. For removing Green Jacket Shoal, Providence River, Rhode Island, twenty-six thousand two hundred and fifty dollars.

Pawcatuck River. Improving Pawcatuck River, Rhode Island, twelve thousand dollars.

Connecticut River. Improving Connecticut River below Hartford, Connecticut: Continuing improvement, twenty-six thousand two hundred and fifty dollars.

Housatonic River. Improving Housatonic River, Connecticut, five thousand dollars.

Thames River. Improving Thames River, Connecticut, Continuing improvement, twenty-two thousand five hundred dollars.

East Chester Creek. Improving East Chester Creek, New York: Continuing improvement, ten thousand dollars.

Hudson River. Improving Hudson River, New York: Continuing improvement, twenty-six thousand two hundred and fifty dollars; of which fifteen thousand dollars may be used for the removal of the rock in channel at Van Wie's Point.

Newtown Creek and Bay. Improving Newtown Creek and Bay, New York: Continuing improvement, thirty-seven thousand five hundred dollars; of which nine thousand three hundred and seventy-five dollars to be expended on west branch between Maspeth avenue and Dual Bridge, at Grand street and Metropolitan avenue; nine thousand three hundred and seventy-five dollars to be expended on main branch between Easterly Grand Street bridge to Metropolitan avenue; and balance on lower end, from Maspeth avenue to the mouth of the creek.

Hell Gate. Improving Hell Gate, New York: Continuing improvement one hundred and twelve thousand five hundred dollars.

Lake Champlain, Narrows. Improving Narrows at Lake Champlain, New York, from Benson, Vermont, to canal locks at Whitehall, New York, thirty thousand dollars.

Ticonderoga River. Improving Ticonderoga River, New York: Continuing improvement, two thousand dollars.

Maurice River Improving Maurice River, New Jersey: Continuing improvement, five thousand dollars.

Passaic River. Improving Passaic River, New Jersey: Continuing improvement, twenty-six thousand two hundred and fifty dollars; of which two thousand two hundred and fifty dollars are to be used above Newark.

Raritan River. Improving Raritan River, New Jersey: Continuing improvement, twenty-six thousand two hundred and fifty dollars.

Shrewsbury River. Improving Shrewsbury River, New Jersey: Continuing improvement, ten thousand dollars.

South River. Improving South River, New Jersey: Continuing improvement, five thousand dollars.

Saint Jones River. Improving Saint Jones River, Delaware: Continuing improvement, ten thousand dollars.

Nanticoke River. Improving Nanticoke River, Delaware: Continuing improvement up to and near the town of Laurel, Delaware, ten thousand dollars.

Monongahela River. Improving Monongahela River, Pennsylvania and West Virginia: Continuing improvement, ninety thousand nine hundred dollars; but no charges or tolls shall be collected on any other part of the river on any commerce on said river which originates above the works herein appropriated for.

Allegheny River.

For beginning the construction of a dam at Herr's Island, in the Allegheny River, near Pittsburgh, Pennsylvania, thirty-seven thousand five hundred dollars.

Improving Allegheny River, Pennsylvania: Continuing improvement, thirty thousand dollars.

Schuylkill River.

Improving Schuylkill River, Pennsylvania: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Delaware River.

Improving Delaware River, Pennsylvania and New Jersey: Continuing improvement from Trenton to its mouth, two hundred and ten thousand dollars; of which thirty thousand dollars shall be applied to improving the channel between Camden, New Jersey, and Philadelphia, Pennsylvania, and seven thousand five hundred dollars, or so much thereof as may be needed, shall be expended on said river and its tidal tributaries above Bridesburg.

Choptank River.

Improving Choptank River, Maryland: Continuing improvement, ten thousand dollars.

Corsica Creek.

Improving Corsica Creek, Maryland: Continuing improvement, ten thousand dollars.

Chesapeake Bay.

For rebuilding piers at Battery Island, head of the Chesapeake Bay, which were carried away by ice, strengthening and protecting the works at that point from future destruction, seventeen thousand two hundred and seventy-five dollars.

Susquehanna River.

Improving Susquehanna River, Maryland and Pennsylvania: Continuing improvement, six thousand dollars; to be expended above the Philadelphia, Wilmington and Baltimore Railroad Bridge.

Pocomoke River.

Improving Pocomoke River, Maryland: Continuing and completing improvement, eight thousand dollars.

Water-way from Chincoteague Bay to Indian River Bay.

Improving, by dredging and otherwise, the inland water-way from Chincoteague Bay, Virginia, to Delaware Bay at or near Lewes, Delaware, to be used from Chincoteague Bay to Indian River Bay, eighteen thousand seven hundred and fifty dollars.

Appomattox River.

Improving Appomattox River, Virginia: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Chickahominy River.

Improving Chickahominy River, Virginia: Continuing improvement, four thousand dollars.

James River.

Improving James River, Virginia: Continuing improvement below Richmond, one hundred and twelve thousand five hundred dollars.

Mattaponi River.

Improving Mattaponi River, Virginia: Continuing improvement, five thousand dollars.

New River.

Improving New River, Virginia: Continuing improvement between the lead-mines, in Wythe County, and the mouth of Wilson's Creek, in Grayson County, ten thousand dollars, together with the three thousand dollars now on hand.

Pamunky River.

Improving Pamunky River, Virginia: Continuing improvement, five thousand dollars.

Rappahannock River.

Improving Rappahannock River, Virginia: Continuing improvement, twenty thousand dollars.

Staunton River.

Improving Staunton River, Virginia: Continuing improvement, ten thousand dollars; one-half of which is to be expended between the mouth of Pig River and the Midland Railroad Crossing.

York River.

Improving York River, Virginia: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Dan River.

Improving Dan River, Virginia: Continuing improvement, ten thousand dollars.

Big Sandy River.

Improving Big Sandy River, West Virginia and Kentucky: Continuing improvement, thirty thousand dollars; of which sum three thousand seven hundred and fifty dollars are to be expended on Tug Fork, in West Virginia, and three thousand seven hundred and fifty dollars on Lavisa Fork, in Kentucky.

Buckhannon River.

Improving Buckhannon River, West Virginia: Continuing improvement, one thousand five hundred dollars.

Great Kanawha River.

Improving Great Kanawha River, West Virginia: Continuing improvement, one hundred and eighty-seven thousand five hundred dollars.

Elk River.

Improving Elk River, West Virginia: Continuing improvement, one thousand five hundred dollars.

Guyandotte River.

Improving Guyandotte River, West Virginia: Continuing improvement, the amount heretofore appropriated is hereby made available for this purpose.

Little Kanawha River.

Improving Little Kanawha River, West Virginia: Continuing improvement, sixteen thousand eight hundred and seventy-five dollars: of which one thousand eight hundred and seventy-five dollars shall be used in continuing the improvementof navigation above the west fork. But no toll shall be collected by any person or corporation for this improved navigation; and such right, if any exist, shall be relinquished, in a manner satisfactory to the Secretary of War, before the expenditure of any of the money herein appropriated for this work.

Cape Fear River.

Improving Cape Fear River, North Carolina: Continuing improvement, one hundred and sixty-eight thousand seven hundred and fifty dollars; of which sum eleven thousand two hundred and fifty dollars are to be expended above Wilmington, the remainder below and opposite the city of Wilmington, including as much of its northeast branch as lies in front of Wilmington, within the city limits.

Contentnia Creek.

Improving Contentnia Creek, North Carolina: Continuing improvement, fifteen thousand dollars.

Currituck Sound.

Improving Carrituck Sound, Coanjok Bay, and North River Bar, North Carolina: Continuing improvement, ten thousand dollars.

Neuse River.

Improving Neuse River, North Carolina: Continuing improvement, twenty-two thousand five hundred dollars.

New River.

Improving New River, North Carolina: Continuing improvement, ten thousan ddollars.

Pamlico and Tar Rivers.

Improving Pamlico and Tar Rivers, North Carolina: Completing improvement, five thousand dollars.

Black River.

Improving Black River, North Carolina, three thousand dollars: *Provided*, That all claims of private parties to the navigation of the river shall be ceded to the United States, free of charge, before the commencement of said improvement.

Roanoke River.

Improving Roanoke River, North Carolina: Continuing improvement, twenty thousand dollars. Two thousand five hundred dollars, or so much thereof as may be necessary, of the aforesaid twenty thousand dollars shall be used for the purpose of removing obstructions in the Thoroughfare and Coshoke Creek.

Trent River.

Improving Trent River, North Carolina: Continuing improvement, three thousand five hundred dollars.

Dan River.

Improving Dan River, North Carolina: Continuing improvement, between Madison, North Carolina, and Danville, Virginia, ten thousand dollars.

Yadkin River.

Improving Yadkin River, North Carolina: Continuing improvement, ten thousand dollars.

Waterway, Beaufort to New River.

Improving the inland waterway between Beaufort Harbor and New River, North Carolina, through Bogue Sound, ten thousand dollars.

Ashley River.

Improving Ashley River, South Carolina: Continuing improvement, one thousand dollars.

Edisto River.

Improving Edisto River, South Carolina: Continuing improvement, three thousand dollars.

Great Pee Dee River.

Improving Great Pee Dee River, South Carolina: Continuing improvement, twenty thousand dollars.

Salkiehatchie River.

Improving Salkiehatchie River, South Carolina: Continuing improvement, two thousand dollars.

Santee River.

Proviso.

Improving Santee River, South Carolina: Continuing improvement, eighteen thousand seven hundred and fifty dollars; no part of which sum to be used for the construction of any road-bridge across the Mosquito Creek Canal: *Provided*, That if salt water be found flowing into said Mosquito Creek, five thousand dollars of said sum, or so much thereof as may be necessary, shall be used for the construction of a flood-gate at the upper end of the canal, to prevent the same.

Waccamaw River.

Improving Waccamaw River, South Carolina: Continuing improvement, fifteen thousand dollars.

Wappoo Cut.

Improving Wappoo Cut, South Carolina: Continuing improvement, five thousand dollars.

Wateree River.

Improving Wateree River, South Carolina: Continuing improvement, seven thousand five hundred dollars.

Congaree River.

Improving Congaree River, South Carolina, seven thousand five hundred dollars.

Altamaha River.

Improving Altamaha River, Georgia: Continuing improvement, twenty thousand dollars; of which ten thousand dollars are to be used on Doboy Bar, or so much thereof as may be necessary.

Chattahoochee River.

Improving Chattahoochee River, Georgia and Alabama: Continuing improvement, twenty thousond dollars.

Coosa River.

Improving Coosa River, Georgia and Alabama: Continuing improvement, forty-five thousand dollars.

Flint River.

Improving Flint River, Georgia: Continuing improvement, twenty thousand dollars; of which sum five thousand dollars are to be expended between Albany and Montezuma, and fifteen thousand dollars below Albany.

Ocmulgee River.

Improving Ocmulgee River, Georgia: Continuing improvement, seven thousand five hundred dollars.

Oconee River.

Improving Oconee River, Georgia: Continuing improvement, nine thousand dollars; one thousand five hundred dollars of said sum to be expended between Skull Shoals and the Railroad Bridge.

Romely Marsh.

Improving Romely Marsh, Georgia: To complete improvement, seventeen thousand four hundred and seventy-five dollars; and so much of said sum as may be necessary may be applied by the engineer in charge, with the approval of the Secretary of War, to pay for work done on said improvement, under the direction of the War Department, since the last appropriation was exhausted.

Savannah River.

Improving Savannah River below Augusta, Georgia: Continuing improvement, fifteen thousand dollars.

Apalachicola River.

Improving Apalachicola River, Florida: Continuing improvement, one thousand dollars.

Caloosahatchee River.

Improving Caloosahatchee River, Florida: Continuing improvement, four thousand dollars.

Choctawhatchee River.

Improving Choctawhatchee River, Florida and Alabama: Continuing improvement, fifteen thousand dollars; of which sum five thousand dollars to be expended below Geneva, and ten thousand dollars to be expended between Geneva and Newton, Alabama.

Conecuh-Escambia River.

Improving Conecuh-Escambia River, Florida and Alabama: Continuing improvement, twelve thousand dollars.

La Grange Bayou.

Improving La Grange Bayou, Florida: Continuing improvement, two thousand dollars.

Manatee and Pease Rivers.

Improving Manatee and Pease Rivers, Florida: Continuing improvement, thirteen thousand dollars; of which five thousand dollars may be expended on Pease River.

Saint John's River.

Improving channel over the bar at the mouth of Saint John's River, Florida: Continuing improvement, one hundred and fifty thousand dollars.

Suwanee River.

Improving Suwanee River, Florida: Continuing improvement, five thousand dollars.

Volusia Bar.

Improving Volusia Bar, Florida: To complete improvement, seven thousand five hundred dollars.

Withlacoochee River.

Improving Withlacoochee River, Florida: Continuing improvement, three thousand dollars.

Alabama River

Improving Alabama River, Alabama: Continuing improvement, fifteen thousand dollars.

Black Warrior River.

Improving Black Warrior River from Tuscaloosa to Daniel's Creek, Alabama, fifty-six thousand two hundred and fifty dollars, together with the forty-seven thousand dollars on hand; to be expended in accordance with the plan adopted by the board of engineers.

Cahawba River

Proviso.

Improving Cahawba River, Alabama: Continuing improvement, seven thousand five hundred dollars: *Provided*, That no part of said sum shall be expended until the officer in charge shall have reported that the railroad and other bridges across said river have been provided with good and sufficient draw-openings.

Tallapoosa River.

Improving Tallapoosa River, Alabama: Continuing improvement, seven thousand five hundred dollars.

Warrior River.

Improving Warrior River, Alabama: Continuing improvement, eighteen thousand seven hundred and fifty dollars; to be expended below Tuscaloosa.

Tombigbee River.

Improving Tombigbee River, Alabama and Mississippi: Continuing improvement, eighteen thousand seven hundred and fifty dollars; to be expended below Vienna, eleven thousand two hundred and fifty dollars; and between Vienna and Fulton, seven thousand five hundred dollars.

Big Sunflowe River.

Improving Big Sunflower River, Mississippi: Continuing improvement, five thousand dollars; of which two thousand dollars to be expended between Woodburn and Lehrton.

Noxubee River.

Improving Noxubee River, Mississippi: Continuing improvement, seven thousand five hundred dollars.

Pascagoula River.

Improving Pascagoula River, Mississippi: Continuing improvement, including bar at the mouth, and from there to the mills at Moss Point, twenty thousand dollars; and the balance of the money now on hand heretofore appropriated for improving Horn Island Pass is to be applied to the same purpose.

Pearl River.

Improving Pearl River, Mississippi: Continuing improvement, seventeen thousand six hundred and twenty-five dollars; of which two thousand two hundred and fifty dollars are to be expended between Edinburg and Carthage, two thousand two hundred and fifty dollars between Carthage and Jackson, and the remainder below Jackson, including bar at the mouth of East Pearl River.

Steele's Bayou.

Improving Steele's Bayou, Mississippi, including Washington Bayou: Continuing improvement, two thousand five hundred dollars.

Tallahatchee River.

Improving Tallahatchee River, Mississippi: Continuing improvement, three thousand five hundred dollars.

Tchula Lake.

Improving Tchula Lake, Mississippi: Continuing improvement, two thousand dollars.

Yallabusha River.

Improving Yallabusha River, Mississippi: Continuing improvement, two thousand dollars.

Bayou Pierre.

Improving Bayou Pierre, Mississippi: Continuing improvement, five thousand dollars.

Yazoo River.

Improving Yazoo River, Mississippi: Continuing improvement, fifteen thousand dollars; of which five thousand dollars, or so much as may be necessary, to be used in repairing snag-boat.

Big Black River.
Proviso.

Improving Big Black River, Mississippi: Continuing improvement, five thousand dollars: *Provided*, That no part of this appropriation shall be used until the State of Mississippi shall have first caused the bridges over said stream south of the Vicksburg and Meridan Railroad to be so constructed as not to obstruct the navigation of said stream.

Amite River.

Improving Amite River, Louisiana: Continuing improvement, two thousand dollars.

Bœuf River.

Improving Bœuf River, Louisiana: Continuing improvement, and for closing Outlet Number One, five thousand dollars.

Bayou Bartholomew.

Improving Bayou Bartholomew, Louisiana and Arkansas: Continuing improvement, five thousand dollars.

Bayou Courtableau.

Improving Bayou Courtableau, Louisiana: Continuing improvement, five thousand dollars.

Bayou D'Arbonne.

Improving Bayou D'Arbonne, Louisiana: Continuing improvement, two thousand dollars.

Bayou Terrebonne.

Improving Bayou Terrebonne, Louisiana: Continuing improvement, ten thousand dollars.

Cypress Bayou.

Improving Cypress Bayou and the lakes between Jefferson, Texas, and Shreveport, Louisiana, Texas and Louisiana: To complete improvement, eighteen thousand dollars.

Tensas River and Bayou Macon.

Improving Tensas River and Bayou Macon, Louisiana: Continuing improvement, four thousand dollars.

Red River.

Improving Red River, Louisiana, and Arkansas: Continuing improvement from Fulton, Arkansas, to the Atchafalaya River, Louisiana, including completing the work at Alexandria, seventy-five thousand dollars; of which sum twenty-five thousand dollars, or so much thereof as may be necessary, shall be used in making a thorough survey of the river from Fulton, Arkansas to the Atchafalaya River, and in completing the survey of Bayou Pierre, Louisiana.

Tchefuncte River and Bogue Falia.

Improving Tchefuncte River and Bogue Falia, Louisiana: Continuing improvement, two thousand five hundred dollars; to be expended in the improvement of Bogue Falia up to Covington.

Tickfaw River.

Improving Tickfaw River, Louisiana: Continuing improvement, two thousand dollars; to be expended on its navigable tributaries.

Ouachita and Black Rivers.

Improving Ouachita River, Louisiana and Arkansas, and Black River, Louisiana: Continuing improvement, seventeen thousand five hundred dollars; of which seven thousand five hundred dollars, or so much thereof as may be necessary, for repairing snag-boat Wagner.

Calcasieu River and Pass.

Improving Calcasieu River and Pass, Louisiana: Continuing improvement to secure a navigable channel eight feet deep over the bars affecting the entrance to said river and pass, and for this purpose the money on hand heretofore appropriated for improvement of Calcasieu River is to be used.

Brazos River.

Improving mouth of Brazos River, Texas: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Buffalo Bayou.

Improving Buffalo Bayou, Texas: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Saint Francis River.

Improving Saint Francis River, Arkansas and Missouri, to the town of Saint Francis: Continuing improvement, eight thousand dollars.

Arkansas River.

Improving Arkansas River, Arkansas: Continuing improvement, seventy-five thousand dollars, according to the plan and recommendation in Appendix V thirteen, Executive Document One, Forty-ninth Congress; of which there are to be expended eight thousand dollars at Pine Bluff, thirteen thousand dollars at Fort Smith, and ten thousand dollars at Dardanelles, or so much thereof under those sums, respectively, as may be necessary at those points.

Removing of snags, etc.

For the removal of snags, wrecks, and other obstructions in the Arkansas River, nineteen thousand eight hundred and seventy-five dollars; of which sum one thousand one hundred and twenty-five dollars, or so much thereof as may be necessary, shall be used to complete the survey of the Arkansas River, between Little Rock, Arkansas, and Wichita, Kansas.

Red River.

Improving Red River, Arkansas, above Fulton, Arkansas, seven thousand dollars.

Little Red River.

Improving Little Red River, Arkansas, three thousand dollars.

Black River.

Improving Black River, Arkansas and Missouri, five thousand dollars.

Petit Jean River.

Improving Petit Jean River, Arkansas, three thousand five hundred dollars.

White River.

Improving White River, Arkansas: Continuing improvement, eighteen thousand dollars; thirteen thousand dollars of which, or so much thereof as may be necessary, to complete the survey of said river; the remainder for general improvement.

Fourche River.

For removing the rock shoals in Fourche River, Arkansas, situate four miles south of Perryville, in Perry County, Arkansas, according to the plans of the engineers for creating a fifty-foot channel, five thousand dollars.

Big Hatchee River.

Improving Big Hatchee River, Tennessee: Continuing improvement, three thousand dollars.

Caney Fork River.

Improving Caney Fork River, Tennessee: Continuing improvement, three thousand dollars.

Clinch River.

Improving Clinch River, Tennessee: Continuing improvement, five thousand dollars.

Cumberland River.

Improving Cumberland River, Tennessee and Kentucky: Continuing improvement above Nashville, with a view to secure in the channel a depth of four feet, commencing with the lock at or near the lower island at Nashville, seventy-five thousand dollars.

Improving Cumberland River below Nashville, Tennessee: Continuing improvement, twelve thousand five hundred dollars.

French Broad River.

Improving French Broad River, Tennessee: Continuing improvement, six thousand dollars.

Hiawassee River.

Improving Hiawassee River, Tennessee: Continuing improvement, two thousand five hundred dollars.

South Fork, Forked Deer River.

Improving South Fork of Forked Deer River, Tennessee: Continuing improvement, five thousand dollars.

Tennessee River.

Improving Tennessee River above Chattanooga, Tennessee: Continuing improvement, seven thousand five hundred dollars.

Improving Tennessee River at Big Mussel Shoals, Little Mussel Shoals, and Elk River Shoals, Alabama: To complete improvements at these localities, two hundred and sixty-two thousand five hundred dollars.

South Fork, Cumberland River.

Improving South Fork of Cumberland River, Kentucky: Continuing improvement, five thousand dollars.

Kentucky River.

Improving Kentucky River, Kentucky: Continuing improvement, one hundred and eighty-seven thousand five hundred dollars.

Tradewater River.

Improving Tradewater River, Kentucky: Continuing improvement two thousand dollars.

Falls of the Ohio River, Louisville.

Improving the Falls of the Ohio River at Louisville, Kentucky: Continuing improvement, according to the last plan of the engineer in charge, and to be first applied to the completion of the work now in progress, one hundred and fifty thousand dollars: *Provided*, That of that sum fifty thousand dollars shall be expended in enlarging the canal basin, as recommended in the last report of the engineer in charge.

Proviso.

Board of engineers to report on

The Secretary of War is hereby authorized and directed to ascertain the value and commercial importance of the works and property of the

the value, etc., of the works of Green and Barren River Navigation Company, and Monongahela Company.

Green and Barren River Navigation Company, situated on the Green and Barren rivers, in the State of Kentucky, and of the Monongahela Navigation Company, situated on the Monongahela River, in the State of Pennsylvania; and in order to acquire such information the Secretary of War shall appoint a board of three competent engineers from the Engineers Corps of the United States Army, which board shall in each case report to the Secretary of War, who shall report thereon to Congress at its next succeeding session; and the cost of such examination shall be paid out of the sum appropriated by this act for surveys:

Proviso.

Provided, That nothing herein shall be construed as committing Congress to the purchase of the said works.

Muskingum River.

Acceptance from Ohio of Muskingum River improvements, canal, etc.

Improvement of the Muskingum River, Ohio, between Zanesville and the mouth of the river, and for operating the same, twenty thousand dollars. And the United States hereby accepts from the State of Ohio the said Muskingum River improvement, and all the locks, dams, and their appurtenances, and the canals, belonging to said improvement, and all the franchises and property of every kind, and rights, in said river, and its improvements, now owned, held, and enjoyed by the State of Ohio, including all water leases and rights to use water under and by virtue of any lease of water now running and in force between the State of Ohio and all persons using said water, hereby intending to transfer to the United States such rights in said leases and contracts as are now owned, held, or reserved by the State of Ohio; but not to affect any right to the use of the water of said river now owned and held by the lessees of any water right under any lease or contract with the State of Ohio. And the United States hereby assumes control of said river, subject to the paramount interest of navigation.

To take effect when property is turned over.

The provisions of this act, so far as they relate to the Muskingum River, shall not take effect, nor shall the money hereby appropriated be available, until the State of Ohio, acting by its duly authorized agent, turns over to the United States all property ceded by the act of the general assembly aforesaid, and all personal property belonging to the improvement aforesaid, and used in its care and improvement, and any balance of money appropriated by said State for the improvement of said river, and which is not expended on the fifteenth day of July, eighteen hundred and eighty-six.

Clinton River.

Improving Clinton River, Michigan: Continuing improvement, six thousand dollars.

Detroit River.

Improving Detroit River, Michigan: Continuing improvement, thirty-seven thousand five hundred dollars.

Saint Clair Ship-Canal.

Improving Saint Clair Ship-Canal Michigan: Continuing improvement, eighteen thousand seven hundred and fifty dollars.

Saint Mary's River.

Improving Saint Mary's River, Michigan: Continuing improvement by a new lock and approaches, two hundred and fifty thousand dollars.

Hay Lake Channel.

Improving Hay Lake Channel, Michigan: Continuing improvement, one hundred and fifty thousand dollars.

Saginaw River.

Improving Saginaw River, Michigan: Continuing improvement, thirty-three thousand seven hundred and fifty dollars; of which sixteen thousand eight hundred and seventy-five dollars are to be used above Bay City, and five thousand dollars in improving the west channel along West Bay City.

Board of engineers to report on value, etc., of Portland Lake Improvement Company Canal and Lake Superior Ship Canal.

The Secretary of War is authorized and directed to appoint a Board of three engineers from the United States Army whose duty it shall be to examine, in all their relations to commerce, the two improved waterways known as the Portage Lake and River Improvement Company Canal and the Lake Superior Ship-Canal Railway and Iron Company Canal, being the improved harbors of refuge and the water communication across Keweenaw Point, from Keweenaw Bay to Lake Superior, by way of Portage River and Lake, in the State of Michigan, with a view to making the same a free passage-way and harbors of refuge, to consider their value and all other matters connected with their usefulness to navigation, and which shall give information as to the expediency of the work and the desirability of their acquisition and improvement. The said board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon; and ten thousand dollars, or so much thereof as may be necessary, is hereby appropriated for this purpose.

Chippewa River.

Improving Chippewa River, Wisconsin: Continuing improvement from the Dalles Dam to its mouth, eighteen thousand seven hundred and fifty dollars.

Fox River.

Survey to be completed as soon as practicable.

Improving Fox River, Wisconsin: Continuing improvement below Montello, on the approved plan, fifty-six thousand two hundred and fifty dollars. And the Secretary of War is hereby directed to have the examination and survey of the Wisconsin River from Portage to the mouth, now being made by a board of engineers, completed as soon as practicable, and a report thereof made on or before the meeting of the next session of Congress. And the sum of six thousand dollars of the above appropriation, or so much thereof as may be necessary, may be expended at or near Portage City to prevent the overflow of the Wisconsin River into the Upper Fox River, so as to prevent injury to the Government works on Fox River; and this expenditure may be made separately, or, if deemed more economical by the Secretary of War, in adding to any protecting works which may be made by the State of Wisconsin.

Saint Croix River.

Improving Saint Croix River, Wisconsin and Minnesota: Continuing improvement, seven thousand five hundred dollars.

Wabash River.

Improving Wabash River, Indiana and Illinois: Continuing work on lock and dam at Grand Rapids, and on the river from Grand Rapids, to its mouth, sixty thousand dollars, and nine thousand dollars to be expended on the river at Grayville.

White River.

Improving White River, Indiana: Continuing improvement, below Hazleton, seven thousand five hundred dollars.

Calumet River.

Provisos.

Right of way to be first secured.

Condemnation proceedings.

Improving Calumet River, Illinois: Continuing improvement, thirty thousand dollars; of which eleven thousand two hundred and fifty dollars are to be used between the Forks and one-half mile east of Hammond, Indiana, five thousand six hundred and twenty-five dollars of which are to be used in dredging the river between the Forks and the State line of Illinois and Indiana, and five thousand six hundred and twenty-five dollars on the river at Hammond, Indiana: *Provided, however*, That no part of said sum, nor any sum heretofore appropriated, except the said eleven thousand two hundred and fifty dollars, for the river above the Forks shall be expended until the entire right of way, as set forth in Senate Executive Document Number Nine, second session Forty-seventh Congress, shall have been conveyed to the United States free of expense, and the United States shall be fully released from all liability for damages to adjacent property-owners, to the satisfaction of the Secretary of War; and if any of the owners of real estate required to be taken or that is damaged for the purpose of straightening or widening that portion of the Calumet River for which the appropriation herein is now made, cannot be induced to convey to the United States such real estate so required, and release their claim for damages caused by said improvement, or should the owner or owners be incapable of conveying and releasing, or should his or her name or residence be unknown, or he or she be a non-resident of the State of Illinois, it shall then be the duty of the United States attorney for the northern district of Illinois to immediately file a petition in any court having jurisdiction thereof, in the manner and as authorized by the laws of the State of Illinois in such cases, for the purpose of ascertaining the just compensation to be paid the respective owners of the land taken or damaged: *Provided, however*, That the other owners of property and parties interested in said improvement shall first execute a bond to the United States, to be approved by the Secretary of War, for the payment of the costs of such proceedings, and to pay any judgment that may be rendered therein; and on failure to do so the proceedings shall be dismissed.

Illinois River.

Improving Illinois River, Illinois: Continuing improvement, one hundred and twelve thousand five hundred dollars; of which sum three thousand seven hundred and fifty dollars may be expended in dredging the river in front of Peoria.

Board of engineers to report on value, etc., of the Hennepin Canal.

The Secretary of War is authorized and directed to appoint a Board of three engineers from the United States Army whose duty it shall be to examine, in all their relations to commerce, the Illinois and Michigan Canal, and the proposed Hennepin Canal, to consider their value and all other matters connected with their usefulness to navigation, and shall report upon the acquisition and improvement of the Illinois and Michigan Canal and the construction of the Hennepin Canal. The said Board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon; and fifteen thousand dollars, or so much thereof as may be necessary, is hereby

Proviso.

appropriated for this purpose: *Provided:* That nothing in this paragraph shall be construed as committing the Government to the said improvement.

Gasconade River.

Improving Gasconda River, Missouri: Continuing improvement, seven thousand five hundred dollars.

Osage River.

Improving Osage River, Missouri: Continuing improvement by snagging and removing obstructions, ten thousand dollars.

Red River of the North.

Improving Red River of the North, Minnesota: Continuing improvement from Breckenridge to the northern boundary-line of the United States, including dredging, removal of snags and bowlders, and construction of wing-dams, and so forth; and the money heretofore appropriated for locks and dams is hereby made available for this purpose.

Yellowstone River.

Improving Yellowstone River between Glendive and the mouth, Montana: Continuing the improvement, eighteen thousand seven hundre and fifty dollars.

Mokelumne River.

Improving Mokelumne River, California, by removing obstructions two thousand five hundred dollars.

Sacramento and Feather Rivers.

Improving Sacramento and Feather Rivers, California, forty thousan dollars of the money heretofore appropriated for improving said rive that may remain unexpended at the end of the present fiscal year, f snagging and dredging operations and the cost of the proceedings hereinafter authorized, also ten thousand dollars to complete dredges a thorized by act of July fifth, eighteen hundred and eighty-four; the balance of said unexpended money not to be used until the Secretary of Wa be satisfied that hydraulic mining hurtful to navigation has ceased o said rivers and their tributaries. If he be not so satisfied, he is hereb instructed to institute such legal proceedings as may be necessary t prevent the washing, sluicing, dumping, or discharging detritus, debri or slickens, caused by or arising from such hydraulic mining, into eith of said rivers or any of its tributaries, or into the San Joaquin River o any of its tributaries, or in or to such place or situation from which suc detritus, debris, or slickens may be liable to be washed or carried b storms or floods into either of said rivers or tributaries; and he is hereb instructed to use out of said sum as much as may be necessary for sai purpose.

Secretary of War to be satisfied that injurious hydraulic mining has ceased.

Legal proceedings to prevent.

San Joaquin River; Stockton and Mormon Sloughs.

Improving San Joaquin River and Stockton and Mormon Slough California: Continuing improvement, eighteen thousand seven hu dred and fifty dollars.

Canal at Cascades, Oreg.

Improving canal at the Cascades, Oregon: Continuing improvemen one hundred and eighty-seven thousand five hundred dollars.

Columbia River.

Improving the Upper Columbia River, including Snake River, Or gon and Washington Territory: Continuing improvement ten thousan dollars.

Improving the mouth of the Columbia River, Oregon, one hundr and eighty-seven thousand five hundred dollars.

Willamette and Columbia Rivers.

Snag-boat.

Improving Lower Wilamette River, and Columbia River below Por land, Oregon: Continuing improvement, seventy-five thousand dollar of which sum twenty-one thousand dollars for a snag-boat to be u on the Willamette and Columbia Rivers, and five thousand dollars be expended on the river in front of Portland.

Willammette River, above Portland.

Improving the Upper Willamette River above Portland, Orego Continuing improvement, ten thousand dollars.

Coquille River.

Improving Coquille River, Oregon: Continuing improvement, twen thousand dollars.

Chehalis River.

Improving Chehalis River, Washington Territory: Continuing i provement, two thousand five hundred dollars.

Cowlitz River.

Improving Cowlitz River, Washington Territory: Continuing i provement, two thousand dollars.

Skagit, Stellaquamish, Nootsack, Snohomish, and Snoqualmie Rivers.

Improving Skagit, Steilaquamish, Nootsack, Snohomish, and Sn qualmie Rivers, Washington Territory: Continuing improvement, t thousand dollars.

Missouri River.

Improving Missouri River from its mouth to Sioux City: Continuing improvement, including necessary work at Omaha, Atchison, Saint Joseph, Fort Leavenworth Reservation, Arrow Rock, Kansas City, Plattsmouth, Brownsville, and Nebraska City, three hundred and seventy-five thousand dollars; to be expended under the direction of the Secretary of War, in accordance with plans and estimates to be furnished by the Missouri River Commission.

From Sioux City to Fort Benton.

Improving Missouri River from Sioux City to Fort Benton: Continuing improvement, sixty thousand dollars, under the direction of the Secretary of War.

Removing obstructions.

For removing obstructions in the Missouri River, twenty-two thousand five hundred dollars.

Ohio River.

Ice-piers.

Provisos.

Riparian rights.

Relinquishment of wharfage rights.

Improving the Ohio River: Continuing improvement, three hundred and seventy-five thousand dollars; out of which sum thirty-seven thousand five hundred dollars are to be expended at Grand Chain in removing rocks and other obstructions to navigation at that locality; also eighteen thousand seven hundred and fifty dollars may be expended in constructing or aiding in the construction of such an embankment on the south side of the Great Miami River, near its junction with the Ohio, as may be necessary to confine the waters of the Great Miami in great floods to the general course of its channel at or near the Ohio, to the end that the formation of the bar in the Ohio River now forming and obstructing navigation may be arrested; also thirty-seven thousand five hundred dollars, or so much thereof as may be necessary, of said appropriation shall be expended in constructing five ice-piers, pursuant to the present or prospective plans of the Chief of Engineers, at or near the following places, to-wit: One at Pomeroy, Ohio; one at Middleport, Ohio; one at Gallipolis, Ohio; and one at Ironton, Ohio; and one at or near Ashland, Kentucky, on the south side of the Ohio River: *Provided*, That the Secretary of War is hereby authorized and directed to obtain, if he can do so without cost to the United States, perpetual leases or conveyances of the riparian rights of the property-owners at each of said localities, in the event said ice-piers, or any one of them, shall be located where there is no improved landing-place: *And provided further*, That at localities where there are improved landings he shall first obtain a relinquishment of wharfage rights and dues in favor of water-craft seeking protection from damage by ice; and no part of this appropriation shall be used for such purpose until the foregoing conditions are complied with. Also, out of said appropriation for the Ohio River eighteen thousand seven hundred and fifty dollars for removing obstruction at the mouth of Licking River; also eleven thousand two hundred and fifty dollars for completing ice-harbor at Four-Mile Bar, near Cincinnati; also twenty thousand dollars, or so much thereof as may be necessary, for Davis Island Dam.

Mississippi reservoir.

Proviso.

For continuing operations upon the reservoirs at the headwaters of the Mississippi Rive , thirty-seven thousand five hundred dollars: *Provided*, That in the opinion of the Chief of Engineers the expenditure of this appropriation and the ultimate completion of this part of the reservoir system will adequately improve navigation.

Upper Mississippi River.

For operating snag-boat on Upper Mississippi River, twenty-two thousand five hundred dollars.

Mississippi River from Saint Paul to Des Moines Rapids.

Test of flume.

Improving Mississippi River from Saint Paul to Des Moines Rapids: Continuing improvement, three hundred and eighty-two thousand five hundred dollars; of which sum six thousand dollars or so much thereof as may be necessary, shall be applied to the removal of the rock at Duck Creek Chain, at the Rock Island Rapids; and of which sum the further amount of fifteen thousand dollars, or so much thereof as may be necessary, may be used by the Secretary of War, in his discretion, for continuing the practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams; but if not so used the sum shall remain as a part of said appropriation, and be used for the purposes first in this paragraph specified.

Mississippi River at Des Moines Rapids Canal.

Improving Mississippi River at Des Moines Rapids Canal, under the modified project, twenty-six thousand two hundred and fifty dollars; of which sum fifteen thousand dollars are to be used for pier construction, in extending the outer wall of canal to the pivot-pier of the bridge.

Dry dock.

For dry-dock at Des Moines Rapids, forty-eight thousand seven hundred and fifty dollars.

Ice-harbor, Dubuque.

Improving ice-harbor at Dubuque, Iowa, the unexpended balance, or so much thereof as shall be necessary, shall be applied to paving instead of riprapping said ice-harbor.

From Des Moines Rapids to Illinois River.

Improving Mississippi River from Des Moines Rapids to the mouth of the Illinois River, including the river at Quincy Bay and the removal of the bars at the mouth of Whipple Creek and Hamburg Bay, including also the strengthening of Sny Island Levee where it crosses Snicarte Slough and other sloughs: Continuing the improvement, one hundred and fifty thousand dollars.

From Illinois River to Ohio River.

Improving Mississippi River from the mouth of the Illinois River to the mouth of the Ohio River, including the completion of the work at Alton, and, at the discretion of the Secretary of War, the protection of the Illinois shore opposite the mouth of the Missouri River: Continuing improvement, three hundred and seventy-five thousand dollars; of which thirty-seven thousand five hundred dollars, or so much thereof as may be necessary, to be expended in extending the work for the protection of the eastwardly bank of the Mississippi River at Cairo, and the prevention of its wash or erosion, commencing at the southerly end of the present Government revetment work and continuing down stream, and twenty-two thousand five hundred dollars for continuing improvement at Cape Girardeau, Missouri, and Montana Point, Illinois: *Provided*, That the Secretary of War, in his discretion may use not to exceed seventy-five thousand dollars of said sum of three hundred and seventy-five thousand dollars to correct the current of the river and improve the channel at Saint Louis.

From Head of the Passes to Ohio River.

Provisos.

Levees.

Improving Mississippi River from Head of the Passes to the mouth of the Ohio River: Continuing improvement, two million dollars; which sum shall be expended under the direction of the Secretary of War, in accordance with the plans, specifications, and recommendations of the Mississippi River Commission: *Provided*, That no portion of this appropriation shall be expended to repair or build levees for the purpose of reclaiming lands or preventing injury to lands or private property by overflows: *Provided, however*, That the Commission is authorized to repair and build levees if, in their judgment, it should be done as part of their plan to afford ease and safety to the navigation and commerce of the river and to deepen the channel. *And provided further*, That no works of bank protection or revetment shall be executed in said reaches or elsewhere until after it shall be found that the completion of the permeable contracting works and uniform width of the high-water channel will not secure the desired stability of the river banks: *Provided, however*, That nothing herein contained shall prevent the construction of revetment works where the banks are caving at Greenville Reach, Delta Point, in front of the cities of Vicksburg, Memphis, Hickman, and Columbus: *And provided further*, That contraction works shall be built at the same time in the wide portions of the river immediately above the said revetment works. Of the amount herein appropriated for the Lower Mississippi, seventy-five thousand dollars are to be expended in continuing the work in progress at New Orleans; one hundred and eighty-seven thousand five hundred dollars for the rectification of the Red and Atchafalaya Rivers by preventing further enlargement of the latter stream and restricting its outlet capacity, and for keeping open a navigable channel through the mouth of Red or Old River into the Mississippi; thirty-seven thousand five hundred dollars in improving navigation in the Greenville Reach, by preventing the bank at Greenville from further caving; seventy-five thousand dollars in deepening the channel at Vicksburg by dredging through the bar existing there; but this last-named sum shall not be expended unless after another examination or survey the Commission shall deem it advisable; and if they shall not, then thirty-seven thousand five hundred dollars shall be expended in the improvement of navigation at Vicksburg by constructing suitable dikes and other appropriate works, and fifty-six thousand two hundred and fifty dollars in completing the work on the river at Memphis; also eighteen thousand seven hundred and fifty dollars for work on the river at Hickman, and eighteen thousand seven hundred and fifty dollars for work on the river at Columbus, Kentucky.

South Pass. Examinations and surveys.

For examinations and surveys at South Pass, of the Mississippi River, pursuant to the act of March third, eighteen hundred and seventy-five, ten thousand dollars.

Survey from Head of the Passes to headwaters.

For survey of the Mississippi River from the Head of the Passes to its headwarters: Continuing survey thirty thousand dollars.

Gauging.

For gauging the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, five thousand dollars.

Removal of snags, etc.

For continuing the removal of snags, wrecks, and other obstructions in the Mississippi River, fifty-six thousand two hundred and fifty dollars.

Columbia River, gauging.

For gauging the waters in the Columbia River, one thousand dollars.

Harbor lines to be established.

SEC. 2. That in places where harbor-lines have not been established, and where deposits of debris of mines or stamp works can be made without injury to navigation, within lines to be established by the Secretary of War, said officer may, and is hereby authorized to, cause such lines to be established; and within such lines such deposits may be made, under regulations to be from time to time prescribed by him.

New York harbor.
Prohibiting deposits in.

SEC. 3. It shall not be lawful to cast, throw, empty, or unlade, or cause, suffer, or procure to be cast, thrown, emptied, or unladen, either from or out of any ship, vessel, lighter, barge, boat, or other craft, or from the shore, pier, wharf, or mills of any kind whatever, any ballast, stone, slate, gravel, earth, slack, rubbish, wreck, filth, slabs, edgings, sawdust, slag, or cinders, or other refuse or mill-waste of any kind, into New York Harbor: *Provided*, That nothing herein contained shall extend, or be construed to extend, to the casting out, unlading, or throwing out of any ship or vessel, lighter, barge, boat, or other craft, any stones, rocks, bricks, lime, or other materials used, or to be used, in or toward the building, repairing, or keeping in repair, any quay, pier, wharf, weir, bridge, building, or other work lawfully erected or to be erected on the banks or sides of said harbor, or to the casting out, unloading or depositing of any material excavated for the improvement of navigable waters, into such places and in such manner as may be deemed by the United States officer supervising the improvement of said harbor most judicious and practicable and for the best interests of such improvement.

Proviso.
Not to prevent improvements.

Regulations, etc., to be prescribed by Secretary of War, to secure economical expenditure of appropriation, etc.

SEC. 4. The Secretary of War shall prescribe such rules and regulations as may be necessary to secure a judicious and economical expenditure of the money herein appropriated, and shall cause to be made and submitted to Congress annual reports, together with maps and plans, including the report of the Mississippi River Commission, on or before December first, giving detailed statements of the work done, contracts made, the expenditures thereunder or otherwise, and balances of money on hand up to November first, and the effect of such work, together with such recommendations as he may deem proper. He shall, at the same time, report to Congress all cases in which piers, breakwaters, locks, and dams, or other structures or works built or made by the United States in aid of commerce or navigation are used, occupied, or injured by a corporation or an individual, and the extent and mode of such use, occupation, or injury. He shall report, at the same time, whether any bridges, causeways, or structures now erected or in process of erection do or will interfere with free and safe navigation.

Work to be done by contract or otherwise.

SEC. 5. It shall be the duty of the Secretary of War to apply the money herein appropriated for improvements other than surveys and estimates, in carrying on the various works, by contract or otherwise, as may be most economical and advantageous to the Government. Where said works are done by contract, such contract shall be made after sufficient public advertisement for proposals, in such manner and form as the Secretary of War shall prescribe; and such contracts shall be made with the lowest responsible bidders, accompanied by such securities as the Secretary of War shall require, conditioned for the faithful prosecution and completion of the work according to such contract, and for the prompt payment of all liabilities incurred in the prosecution thereof for labor and material.

Contracts.

Examinations and surveys.

SEC. 6. The Secretary of War is hereby directed, at his discretion, to cause examinations or surveys, or both, to be made, and the cost of improvements to be estimated, at the following localities, to wit:

In the States of—

ARKANSAS.

Arkansas.

Re-examination of Little River.

The lakes connecting with Red River, between Shreveport, Louisiana, and Fulton, Arkansas.

Re-examination of Ouachita above Camden, Arkansas.

Saline River.

Cache River.

CALIFORNIA.

California.

San Pedro Bay near the entrance to Wilmington Harbor, with a view to establishing an outer harbor for the protection of deep-draught vessels.

Mouth of Smith's River.

Crescent City Harbor, with a view to a sea-wall from Battery Point to Flat Rock.

Connecticut.

CONNECTICUT.

Five-Mile River Harbor.

Resurvey of Duck Island Harbor, on Long Island Sound, including plans, specifications, and estimate of cost for making the same a harbor of refuge.

Dakota.

DAKOTA TERRITORY.

James River.

Delaware.

DELAWARE.

Duck Creek.

Florida.

FLORIDA.

Punta Rassa Harbor.

Resurvey of Tampa Bay, including Hillsborough River up to the city of Tampa.

Resurvey of outer and inner bars at Pensacola.

Charlotte Harbor, including San Carlos Bay.

Clear Water Harbor, including Anclote and Saint Joseph's Bays and the Narrows into Boga Ciega Bay.

Wakulla River from its mouth to Wakulla Springs.

Survey of the channel from Haul-over, on Indian River, to Gilbert's Bar.

Saint Augustine, for a deep sea-channel on the outer bar.

Georgia.

GEORGIA.

Savannah River from cross-tides above Savannah to the bar, with a view to obtaining twenty eight feet of water in the channel.

Flint River from Montezuma to Old Agency.

From Doboy Island to Doboy Bar.

Jekyl Creek.

Illinois.

ILLINOIS.

Farm Creek, with a view to changing its course.

Kaskaskia River from New Athens to mouth.

Bars in Hamburg Bay.

Calumet River from the forks of the river near its entrance to Lake Calumet to Riverdale; also Calumet River from Riverdale to Blue Island.

Mississippi River at Rush Island Bend and Ivy Landing, with a view to confining and deepening the channel.

Indiana

INDIANA.

For a survey of the Ohio River, near the city of Evansville, Indiana, with a view to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.

Kentucky.

KENTUCKY.

Pond River.

The Secretary of War is directed to report to the next session of Congress whether or not the Government dry-dock at the Louisville and Portland Canal is adequate for the purposes of commerce, and what alterations, if any, are necessary, and the cost of making the same.

Licking River from Farmer's to West Liberty.

Salt River.

For ice harbor at Paducah, Kentucky.

The bar at the mouth of Limestone Creek, in the harbor of Maysville.

Louisiana.

LOUISIANA.

Little River.

Bayou Rouge.

Dugdemona River.

Mouth of Bayou Plaquemine, with a view to its connection with the Mississippi River by locks; also Bayou Plaquemine and other connecting streams, to form the best route to Grand Lake.

Bague Falia from present landing to Covington.

Calcasieu Pass, the two bars obstructing the navigation thereof.
Mouth of Calcasieu River, the bar obstructing its mouth.
Bayou Terrebonne from Houma to Thibodeaux.
Bayou Teche from Saint Martinsville to Fort Barre.
Mouth of Bayou La Fourche, with a view to the construction of a lock and dam; Clear Lake, Black Bayou, Red Bayou, Black Lake, and Kelley Bayou, to reopen navigable communication between those streams and Red River; Bayou La Fourche, to secure navigation at low water.
Cornay River.
Ouchita River from Camden to mouth, with a slackwater navigation.
Bayou Vermillion, to secure navigation from Abbeville to the railroad bridge of the Louisiana and Texas Railroad.
Bayou Rondeway.
Cypress Bayou.
Bayou Vidal.

MAINE.

Maine.

Bayoduce River between the towns of Penobscot and Brooksville.
Big Rapids of Saint John's River.
Camden Harbor.
Rockport Harbor.
Kennebec River at Bath, and from Augusta to lower end of Perkin's Island.
Saint George's River from Warren to to Thomaston.
Matinicus Isle, with a view to a harbor of refuge.
Penobscot River from Bangor to Bucksport Narrows.
Saint Croix River from Ferry Point Bridge, at Calais, to Breakwater Ledge.
Bar Harbor, Maine, with the view to establishing a breakwater and deepening the waters of said harbor, and especially the channel between Rodick's Island and Mount Desert Island.

MARYLAND.

Maryland.

Cambridge Harbor.
Fairlee Creek.
Patuxent River from Benedict to Hills Landing.
For widening the channel of Baltimore Harbor to six hundred feet.

MASSACHUSETTS.

Massachusetts.

Manchester Harbor.
Duxbury Harbor.
Wellfleett Harbor.
Falmouth Harbor of Refuge.
Vineyard Haven Harbor.
Cottage City Harbor.
Menemsha Harbor of Refuge.
Taunton River.
Winthrop Harbor.
New Bedford Harbor.

MICHIGAN.

Michigan.

Bar in Saint Clair River opposite Saint Clair City.
Grand River.
North River between Essex and North Bridges.
Biddle's Point at Mackinac Harbor, with a view to a breakwater.
Harbor at Forestville, Lake Huron.
Pigeon River.
Mouth of Black River, Saint Clair County.
Carp River at Leland, with a view to affording an entrance to Carp Lake for harbor of refuge.
Lake Michigan at Empire, with a view to cutting the channel across the bar from Lake Michigan to Bar Lake.
Grand Traverse Bay, with a view to connecting it with Torch Lake, near Eastport.
Pinepog River.
Rouge River at its junction with Detroit River, and up the river to bridge of Saint Louis and Wabash Railroad.
Torch Lake Channel, Lake Superior.

Minnesota.

MINNESOTA.

Red River of the North from Moorehead to Fergus Falls.

Red Lake River from Grand Forks to Red Lake.

Mississippi River between Saint Paul and Saint Anthony's Falls.

Minnesota River with a view to its improvement by locks and dams.

Mississippi.

MISSISSIPPI.

Tombigbee River, to ascertain what improvement is necessary to make said river continuously navigable from Vienna, Alabama, to Walker's Bridge, Mississippi.

Cassity Bayou.

Noxubee River, to ascertain whether it can be made continuously navigable by a system of locks and dams, or otherwise.

Bear Creek.

Missouri.

MISSOURI.

Resurvey of the Osage River from its mouth to Osceola, with a view to movable locks and dams, or other methods of improvement.

Little River from Hornersville to its junction with the Saint Francis River.

Saint Francis River from Greenville to the Arkansas State line.

New Hampshire.

NEW HAMPSHIRE.

Bellamy River.

North Carolina.

NORTH CAROLINA.

Alligator River.

Lockwood's Folly River.

Lumber River.

Yadkin River from South Carolina line to the Narrows.

Catawba River.

New Jersey.

NEW JERSEY.

Thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City.

Channel back of Brigantine Beach, between Absecon and Brigantine Inlets.

New York.

NEW YORK.

Channel between Jamaica Bay and Rockaway Inlet.

The East River with a view to the removal of a ledge of rocks situated between five and six hundred feet from the foot of Tenth and Eleventh streets in the city of New York.

Spring Creek.

Waddington Harbor.

Mouth of Patchouge River.

Hudson River between New Baltimore and Coxsackie.

Peter's Neck Bay.

Tonawanda Harbor and Niagara River between Black Rock and Tonawanda, with a view to a sixteen-foot channel.

Glen Cove Harbor.

Oregon.

OREGON.

Wood River.

Link River.

Snislaw River and Bar.

Coquille River between Coquille City and Myrtle Point.

Nehalem Bay and Bar.

Tillamook Bay and Bar.

Umpqua River.

Ohio.

OHIO.

Sandusky Harbor, with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city.

Big Hockhocking River from its mouth to Coolville.

Chagrin River at its mouth.

PENNSYLVANIA.

Pennsylvania.

Darby Creek.

RHODE ISLAND.

Rhode Island.

Little Narragansett Bay, entrance to the wharves at Watch Hill.

SOUTH CAROLINA.

South Carolina.

Mosquito Creek between the South Edisto and Ashepoo Rivers, with a view to connect the South Edisto with the Ashepoo at or near Fenwick's Island.

Mingo Creek.

Clark's Creek.

Little Pee Dee River.

Alligator River and other waters connecting Santee River and Bull's Bay.

TENNESSEE.

Tennessee.

North Fork of the Forked Deer River below Dyersburg.

Obeils River from the point where improvements have heretofore been made to the mouth of the West Fork.

TEXAS.

Texas.

Cedar Bayou, where it empties into Galveston Bay.

VIRGINIA.

Virginia.

Mattox Creek.

Nansemond River.

Louisa Fork of Sandy River.

Roanoke River from Clarkesville, Virginia, to Eaton Falls, North Carolina.

Hunters Creek.

WEST VIRGINIA.

West Virginia.

Meadow River.

Gauley River.

Coal River.

WISCONSIN.

Wisconsin.

Harbor at Hudson, Lake Saint Croix.

Examination and report on the cause of the extraordinary overflows of the Chippewa River, and what means, if any, can be adopted to prevent their recurrence.

Examinations, survey, etc., not specially provided for.

SEC. 7. For examinations, surveys, and contingencies, and for incidental repairs, for which there is no special appropriation, for rivers and harbors, one hundred thousand dollars: *Provided*, That no survey shall be made of any harbors or rivers until the Chief of Engineers shall have directed a preliminary examination of the same by the local engineer in charge of the district, or an engineer detailed for the purpose; and such local or detailed engineer shall report to said Chief of Engineers, whether, in his opinion, said harbor or river is worthy of improvement, and shall state in such report fully and particularly the facts and reasons on which he bases such opinion, including the present and prospective demands of commerce; and it shall be the duty of the Chief of Engineers to direct the making of such survey if, in his opinion, the harbor or river proposed to be surveyed be worthy of improvement by the General Government; and he shall report to the Secretary of War the facts, and what public necessity or convenience may be subserved thereby, together with the full reports of the local engineer. Said reports of preliminary examinations and surveys shall be made to the House of Representatives, and are hereby ordered to be printed when so made.

Proviso.

Preliminary examinations to be made before surveys.

Reports to be made to House of Representatives and printed.

SEC. 8. That the Secretary of War shall report to Congress, at its next and each succeeding session thereof, the name and place of residence of each civilian engineer employed in the work of improving rivers and harbors by means and as the result of appropriations made in this and succeeding river and harbor appropriation bills, the time so employed, the compensation paid, and the place at and work on which employed.

Names of civilian engineers to be reported to Congress, etc.

Approved, August 5, 1886.

August 5, 1886.

CHAP. 930.—An act to provide for protecting the interests of the United States in the Potomac Flats, in the District of Columbia.

Potomac River Flats, D. C.

Suit to be brought to establish title, etc., in land affected by the improvement.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be the duty of the Attorney-General of the United States to institute, as soon as may be, in the supreme court of the District of Columbia, a suit against all persons and corporations who may have or pretend to have any right, title, claim, or interest in any part of the land or water in the District of Columbia within the limits of the city of Washington, or exterior to said limits and in front thereof toward the channel of the Potomac River, and composing any part of the land or water affected by the improvements of the Potomac River or its flats in charge of the Secretary of War, for the purpose of establishing and making clear the right of the United States thereto.

Who to be parties defendant; service of process.

SEC. 2. That the suit mentioned in the preceding section shall be in the nature of a bill in equity, and there shall be made parties defendant thereto all persons and corporations known to set up or assert any claim or right to or in the land or water in said first section mentioned, and against all other persons and corporations who may claim to have any such right, title, or interest. On the filing of said bill process shall issue and be served, according to the ordinary course of said court, upon all persons and corporations within the jurisdiction of said court; and public notice shall be given, by advertisement in two newspapers published in the city of Washington, for three weeks successively, of the pendency of said suit, and citing all persons and corporations interested in the subject-matter of said suit, or in the land or water in this act mentioned, to appear, at a day named in such notice, in said court, to answer the said bill and set forth and maintain any right, title, interest, or claim that any person or corporation may have in the premises; and the court may order such further notice as it shall think fit to any party in interest.

Effect of decree.

SEC. 3. That the said cause shall then proceed with all practicable expedition to a final determination by said court of all rights drawn in question therein; and the said court shall have full power and jurisdiction by its decree to determine every question of right, title, interest, or claim arising in the premises, and to vacate, annul, set aside, or confirm any claim of any character arising or set forth in the premises; and its decree shall be final and conclusive upon all persons and corporations parties to the suit, or who shall fail, after public notice as hereinbefore in this act provided, to appear in said court and litigate his, her, or its claim, and they shall be deemed forever debarred from setting up or maintaining any right, title, interest, or claim in the premises.

Interests adverse to the United States to be valued and reported to Congress.

SEC. 4. That if, on the final hearing of said cause, the said supreme court of the District of Columbia shall be of opinion that there exists any right, title, or interest in the land or water in this act mentioned in any person or corporation adverse to the complete and paramount right of the United States, the said court shall forthwith and in a summary way proceed to ascertain the value of any such right, title, interest, or claim, exclusive of the value of any improvement to the property covered by such right, title, or interest made by or under the authority of the United States, and report thereof shall be made to Congress.

Appeal to Supreme Court of the United States.

SEC. 5. That from the final decree of the supreme court of the District of Columbia, and every part thereof, in the premises, an appeal shall be allowed to the United States, and to any other party in the cause complaining of such decree, to the Supreme Court of the United States, which last-mentioned court shall have full power and jurisdiction to hear, try, and determine the said matter, and every part thereof, and to make final decree in the premises; and the said cause shall, on motion of the Attorney-General of the United States, be advanced to the earliest practicable hearing: *Provided,* That no payment under any such judgment shall be made unless hereafter authorized by Congress.

Cause to be advanced.

Proviso.

Payments.

No money to be spent on property in dispute until final decision.

SEC. 6. That until the final decision of the matters hereinbefore in this act mentioned shall have been had, no moneys appropriated for the improvement of the Potomac River within the District of Columbia, the establishment of harbor-lines in the District of Columbia, and the raising of the flats therein shall be expended otherwise than upon property in respect of which there is no claim adverse to the title of the United States or for the improvement of navigation in the said river.

Approved, August 5, 1886.

RESOLUTIONS.

[No. 7.] **Joint resolution authorizing the Superintendent of Public Buildings and Grounds in the District of Columbia to supply plants and shrubs to fill certain vases in the Pension building.**

March 29, 1886.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Superintendent of Public Buildings and Grounds in the District of Columbia be, and is hereby, authorized and directed to supply, and to keep supplied, from the public green-houses and nurseries, the vases around the interior court of the Pension Building with plants and shrubs suitable thereto.

Pension building.

Vases in interior court to be filled with plants and shrubs.

Approved, March 29, 1886.

[No. 18.] **Joint resolution to provide temporarily for the expenditures of the Government.**

July 1, 1886.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That all appropriations for the necessary operations of the Government under existing laws which shall remain unprovided for on the thirtieth day of June, eighteen hundred and eighty-six be, and they are hereby continued and made available for a period of fifteen days from and after that date, unless the regular appropriations therefor provided for in bills now pending in Congress, shall have been previously made for the service of the fiscal year ending June thirtieth, eighteen hundred and eighty-seven; and in case the appropriations, or any of them, hereby continued, are or is, insufficient to carry on the said necessary operations, a sufficient amount is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to carry on the same: *Provided,* That no greater amount shall be expended therefor than will be in the same proportion to the appropriations of the fiscal year eighteen hundred and eighty-six, as fifteen days time bears to the whole of said fiscal year: *Provided further,* That authority is also granted for continuing during the same period the necessary work required for public printing and binding, and for all other miscellaneous objects embodied in the sundry civil and naval appropriation acts, in advance of appropriations to be hereafter made for said objects: *And provided further,* All sums expended under this act shall be charged to and be deducted from the appropriations for like service for the fiscal year ending June thirtieth, eighteen hundred and eighty-seven.

Temporary provision for expenses of the Government for fifteen days.

Post, p. 345.

Approved, July 1, 1886.

[No. 24.] Joint resolution to continue the provisions of a joint resolution approved July first, eighteen hundred and eighty-six, entitled a "Joint Resolution to provide temporarily for the expenditures of the Government."

July 15, 1886.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the provisions of a joint resolution entitled a "Joint Resolution to provide temporarily for the expenditures of the Government," approved July first, eighteen hundred and eighty-six, be, and the same are hereby, extended and continued in full force and effect to and including the thirty-first day of July, eighteen hundred and eighty-six.

Temporary provision for expenses of the Government extended to July 31, 1886.

See ante, p. 343.

Approved, July 15, 1886.

[No. 13.] Joint resolution for the relief of William L. Dunlop, trustee.

May 26, 1886.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the United States, in favor of the said William L. Dunlop, of the District of Columbia, as trustee of the estate of George Lowry, late of said District, deceased, his heirs

William L. Dunlop, trustee.

Release of right of United States in lot 13, square 75, Washington City, to.

and assigns, hereby surrender, abandon, and forever release all right or claim they may have, by reason of any escheat, to any part of lot numbered thirteen, in square numbered seventy-five, in the city of Washington, in the District of Columbia, as the same is known and distinuished on the plan or plat of said city and included in the following lines and bounds, to wit: Beginning for the same at a point on the line of the southwest side of Pennsylvania avenue seventy-nine feet three inches from the stone planted at the northwest corner of the square, and running thence along the line of Pennsylvania avenue toward said corner-stone, twenty feet; thence at right angles to the avenue back to an alley nine feet wide, heretofore laid off in a lease to Thomas Y. Sprogell; thence with the line of said alley due east till it intersects with said Sprogell's line; thence with said Sprogell's line to the place of beginning, with the free use and privilege of the said alley of nine feet in width, and with the brick dwelling-house and building thereon.

Description.

Approved, May 26, 1886.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

CATIONS, ETC.

APPENDIX No. 1.

POST OF WILLETS POINT AND ENGINEER SCHOOL OF APPLICATION.

ANNUAL REPORT OF LIEUTENANT-COLONEL C. B. COMSTOCK, CORPS OF ENGINEERS, BVT. BRIG. GEN. U. S. A., OFFICER IN COMMAND, FOR THE FISCAL YEAR ENDING JUNE 30, 1886.

WILLETS POINT, NEW YORK HARBOR,
July 16, 1886.

GENERAL: I have the honor to submit the annual report for the Post at Willets Point and the Engineer School of Application.

I relieved Lieut. Col. H. L. Abbot of these duties on March 15, 1886.

On June 30, 1886, the garrison, present and absent, at Willets Point, consisted of the following officers and men, viz.:

Post Commander.

Lieut. Col. C. B. Comstock, Corps of Engineers.

General staff.

Maj. J. C. G. Happersett, surgeon, U. S. A.
Captain Charles Richard, assistant surgeon, U. S. A., and 4 enlisted men.

Field staff and band.

Maj. W. R. King, Corps of Engineers, commanding Battalion of Engineers.
First Lieut. S. W. Roessler, Corps of Engineers, adjutant.
First Lieut. James L. Lusk, Corps of Engineers, quartermaster, and 11 enlisted men.

Company A, Battalion of Engineers.

Capt. J. G. D. Knight, Corps of Engineers, commanding company.
First Lieut. H. E. Waterman, Corps of Engineers.
Second Lieut. D. DuB. Gaillard, Corps of Engineers.
Second Lieut. W. E. Craighill, Corps of Engineers, and 112 enlisted men.

Company B, Battalion of Engineers.

Second Lieut. H. M. Chittenden, Corps of Engineers, commanding company.
Second Lieut. Harry Taylor, Corps of Engineers.
Second Lieut. Joseph E. Kuhn, Corps of Engineers, and 112 enlisted men.

Company C, Battalion of Engineers.

First Lieut. W. C. Langfitt, Corps of Engineers, commanding company.
Second Lieut. Irving Hale, Corps of Engineers.
Second Lieut. C. E. Gillette, Corps of Engineers.
Second Lieut. W. L. Sibert, Corps of Engineers, and 112 enlisted men.

Unassigned.

First Lieut. C. McD. Townsend, Corps of Engineers.

Attached.

First Lieut. Allyn Capron, First Artillery.
Second Lieut. C. G. Treat, Fifth Artillery.
Second Lieut. Isaac N. Lewis, Second Artillery.
Total, 21 officers and 351 enlisted men.

Aside from the ordinary duties at military posts, the officers and men of the Engineer Battalion are required to be familiar with the details of pontoniering, sapping and mining, siege works, and, what is still more difficult, with the complicated details of electrical torpedo defense, the latter requiring a large amount of theoretical and practical instruction. Since at the outbreak of a foreign war the Engineer Battalion would be the only body of soldiers having any knowledge of our fixed torpedo defense, the importance of keeping the Battalion up to at least its present strength and in the highest state of efficiency is evident. During the year it has received practical and theoretical instruction in the subjects mentioned.

The water supply of the post is inadequate, being obtained from wells and from cisterns. This makes any general system of sewerage impracticable, and the need of both sewers and an ample water supply should at once be met. In case of fire, with the present water supply, there would be much danger of a great conflagration. The town of Flushing has constructed water-works and its water authorities have made propositions in reference to laying pipes to the Willets Point reservation, which shall supply 600 persons, for $5,000 for the first year and an annual rental of $3,000 thereafter. The Board on the water supply and sewerage of Willets Point constituted by Special Orders No. 187, Adjutant-General's Office, August 17, 1885, objected to the Flushing water supply on the score of its being derived from surface drainage. Flushing now obtains its water from wells sunk in the sand and the water is of good quality. This Board, composed of officers of rank in the Quartermaster's, Medical, and Engineer departments, stated in their report (of which a copy is inclosed, Appendix E) that the present water supply "is entirely inadequate to the comfort of the garrison for ordinary sanitary purposes and for protection against fire." The Board recommended an artesian well. That has been tried and has failed, and the Flushing supply seems now the only resource. The estimate of the Board for water supply was $30,000. But, as the reservoir and pumping-engine their plan contemplated would be unnecessary if water were obtained from Flushing, this estimate may be reduced to $17,000, as the amount needed for next year. The same Board states that there is no system of sewerage on the post, and estimate the cost of such a system, including the necessary plumbing, at $12,000.

During the past winter the lack of quarters has been partially relieved by several officers occupying but a single room, instead of the two to which they are entitled. The number of officers the coming winter will probably be two to four more than last winter, and the two sets of quarters in the old mess-hall are so bad that they should be abandoned. There is needed a new double house, with quarters for four lieutenants, costing $12,000.

Detailed estimates are not submitted, since the current Army appropriation bill requires them to be made by the Quartermaster's Department.

The Board of Visitors has recommended that permanent barracks be gradually constructed for the companies here, and Lieutenant-Colonel Abbot prepared a plan and estimate for a one-company barrack, which are returned herewith. (See Appendix F.)

The following modifications in the plan are proposed:

1. That the barrack be heated by steam or furnaces instead of by stoves.
2. That a basement be put under a part or all of the building, so that when the present mess-hall and kitchens become unserviceable the basement can be used for that purpose.
3. That balconies be put on the rear wing.
4. That latrines and cisterns be provided.

Without change in cost or in general dimensions, it may be advisable to change the relative dimensions of the wings when the precise site for the barrack is fixed.

The cost of the barrack for 150 men, with these changes, is estimated at $35,000.

There is a large amount of stone belonging to the fort on hand and a large amount of ponton material, which is deteriorating. So far as is practicable, this material should be used in constructing new buildings, thus reducing their cost.

The Engineer School of Application is at present organized under a project approved by the Secretary of War, given as Appendix A.

The object of the school is primarily to form a body of officers and enlisted men who shall be theoretically and practically familiar with the fixed electrical torpedo defense of our harbors, and who, at the outbreak of war, with numbers too small to do the work themselves, would yet have the knowledge needed to supervise others in promptly putting down torpedo defenses.

Its secondary object is to give practical instruction in military engineering, electricity, astronomy, surveying, and photography, and theoretical instruction in civil engineering. An idea of the scope of the instruction can be formed from the orders arranging details of work, and given as Appendices B, C, and D of this report.

The following-named artillery officers, First Lieut. Allyn Capron, First Artillery; Second Lieut. Charles G. Treat, Fifth Artillery; Second Lieut. Isaac N. Lewis, Second Artillery, were detailed for a seven-months course in torpedo instruction at Willets Point, and were relieved on July

1, 1886. They showed much interest in the work, and would be available for planting torpedoes should an emergency arise.

The following is a recapitulation of the funds required for the post at Willets Point and for the Engineer School of Application for the fiscal year 1886-'87:

ESTIMATE OF FUNDS.

For water supply, provided $5,000 may be paid to the town of Flushing therefor	$17,000
For sewerage and plumbing	12,000
For one double building for officers' quarters	12,000
For one brick barrack for 150 men, provided that any available material at Willets Point may be used	35,000
For purchase, for the Engineer School of Application, of books, instruments, stationery, clerk hire, or extra-duty pay to enlisted men employed as clerks, and miscellaneous	1,000
Total	77,000

Very respectfully, your obedient servant,

C. B. COMSTOCK,
Lieutenant-Colonel of Engineers, Commanding.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

APPENDIX A.—ORGANIZATION OF ENGINEER SCHOOL OF APPLICATION.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 20, 1885.

SIR: I have the honor to submit herewith a report of the Board of Engineers for Fortifications, &c., upon the reorganization of the Engineer School of Application, at Willets Point, made in compliance with instructions based upon your authority as granted in indorsement upon my letter of August 18, 1884.

In submitting this report I have to say that the first condition necessary to make the school at Willets Point efficient as a practical school of instruction for engineer officers is to insure its permanency.

BOARD OF VISITORS.

The Board of Engineers for Fortifications, &c., in New York, together with such other officers of the Corps of Engineers above the rank of major as shall be stationed in New York City, should constitute a Board of Visitors, which should visit the school at least twice in each year and make a thorough and detailed inspection of everything connected with it, submitting a report thereof to the Secretary of War, through the Chief of Engineers, with such recommendations in reference to the school as may be deemed necessary.

ACADEMIC STAFF.

The academic staff of the school should consist of the commanding officer, *at least* one other field officer, and the captains commanding the companies; the adjutant of the battalion of Engineers should be the secretary.

TOURS OF DUTY.

The tours of duty of the commanding officer and of the field officers detailed for the school should be as long as possible, subject to the exigencies of the service.

The regular tour of the captains should be not less than three years, and only one of them should be relieved in any single year.

As the duty of instruction in some branches of the profession will probably devolve upon the adjutant and quartermaster, who should be first lieutenants of high rank, the tour of each should be not less than three years, and only one of them should be relieved in any one year.

GRADUATES ASSIGNED TO THE CORPS OF ENGINEERS.

All graduates of the Military Academy who may be assigned to the Corps of Engineers, at the expiration of their graduating leave, should, as far as circumstances will permit, be ordered to the School of Application at Willets Point, and their tour of service should not be less than two and a half years.

LIBRARY.

Provision should be made from the appropriation for incidental expenses of the Engineer Depot at Willets Point for the annual purchase of a few new standard books for the library of the school.

INSTRUCTION OF ENLISTED MEN.

The enlisted men of the Battalion of Engineers should be instructed not only in their duties as soldiers of the line of the Army, but also in sapping, mining, pontoniering, the duties of a Torpedo Corps, &c.

The non-commissioned officers of the Battalion should receive theoretical as well as practical instruction.

REORGANIZATION OF THE ENGINEER SCHOOL OF APPLICATION.

The following plan of reorganization of the school, mainly a repetition of the ideas submitted in the report of the Board of Engineers, is recommended for approval.

The establishment shall be designated "The Engineer School of Application of the Army of the United States."

It shall be divided into five departments, as follows:

Submarine Mining.—Including electricity, our own and foreign systems of defensive torpedo warfare, and modern high explosives.

Military Engineering.—Including the operations of armies in the field, sea-coast defense, modern siege operations, and modern ordnance.

Military Photography.—Including all methods of map multiplication in the field, and the use of the camera.

Practical Astronomy.—Including the best methods and the use of instruments employed upon the more important boundary surveys.

Civil Engineering.—Including practical surveying, river and harbor improvements, and barometric hypsometry.

OBJECT OF ESTABLISHMENT.

The object of the establishment should be to conduct researches in the branches of science applicable to the duties of the Corps of Engineers, to instruct newly assigned officers in the profession, and to train the enlisted men of the Battalion of Engineers to the highest possible degree of efficiency.

COMMAND.

The establishment, under the Chief of Engineers, should be under the military command of the officer of Engineers, assigned to the command of the Post of Willets Point, N. Y.

ACADEMIC STAFF.

The academic staff should consist of the commandant of the other field officers of the school, and of the captains commanding the Engineer companies stationed at Willets Point. Any other officer charged with a department of instruction should be a member when his branch is under consideration. The adjutant of the Battalion of Engineers should be the secretary of the academic staff.

STUDENTS.

The students should consist of the subaltern officers serving with companies, of such other officers as may be authorized to study the course in whole or in part, and of the non-commissioned officers and privates of the Battalion of Engineers stationed at Willets Point.

EXAMINATIONS.

There should be two semi-annual examinations of the officers under instruction during the first and second years, and one during the last half year of their service with the Battalion. These examinations should be conducted by the academic staff in the presence of one or more members of the Board of Visitors. Careful records should be kept, which should be duly reported to the Chief of Engineers by the commanding officer of the post.

These semi-annual examinations should take place on or about the end of January, and on or about the end of April.

Their scope, subject to the approval of the Chief of Engineers, should be designated by the commandant on the recommendation of the academic staff.

Officers of other arms of service attached to the school should be examined by the academic staff at such time as may be ordered by the commandant, on the approval of the Chief of Engineers, and the results of such examinations should be reported, through the Chief of Engineers, to the General Commanding the Army when such officers are relieved from duty, or sooner if deemed expedient by the academic staff.

RESEARCHES.

The researches to be conducted at Willets Point shall be such as may be approved by the Chief of Engineers.

COURSE OF INSTRUCTION.

The annual course of instruction should be divided into two parts—winter and summer. The former, which will be chiefly library and laboratory work, should extend from about the first of December to about the end of April. The latter should include the rest of the year, and will be chiefly practical. So far as the season permits, theory and practice should at all times be combined.

During the summer season each member of the academic staff should be assigned by the commandant to the charge of one of the departments of instruction, and as far as practicable this detail should be changed every year. In making such assignments, however, no captain should be relieved of responsibilities which properly pertain to his military command.

During the winter season the supervision of the course should be divided among the academic staff.

The following should be the general program of instruction, the details being ordered by the commandant, upon the approval of the Chief of Engineers, upon the recommendation of the academic staff, which shall designate the necessary text books.

COURSE FOR OFFICERS.

The young officers should be required to assist in the various researches in military science conducted at Willets Point, with a view to familiarizing them with the methods employed in such work.

Their technical course of study should be arranged as far as practicable upon the following basis. Details should be arranged by the academic staff:

	First winter.	Second winter.	Third winter.
	Weeks.	*Weeks.*	*Weeks.*
Submarine mining	14	7	6
Chemistry and military photography	4	4	....
Military engineering	....	7	3
Civil engineering	....	....	11

During the summer much time will be occupied by the regular company duties, and it is not deemed possible to arrange the course as definitely as for winter.

The following schedule indicates the general disposition of time:

	First summer.	Second summer.
	Weeks.	*Weeks.*
Submarine mining	7	6
Practical astronomy	5	6
Military engineering	(*)	(*)
Civil engineering	4	7

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* Sapping, mining, and pontoniering drills. Infantry drills and target practice with their companies.

COURSE FOR ENLISTED MEN.

The course of instruction for the enlisted men of Engineers should be determined by the academic staff, and should be repeated annually, more care and time being devoted to recruits than to instructed soldiers.

In submarine mining recruits should receive three months and instructed soldiers one month of drilling, covering seven hours daily. These drills should include all the duties of the loading-room, boat service, and the handling and firing of modern high explosives. Grand groups of mines should be frequently planted and raised, and the entire familiarity with the service which practice alone can give should be insisted upon.

In field fortification and sapping each company should have one month's regular practice in the molding-room, and such outside work as may be found practicable.

In pontoniering each company should have two months' regular practice, arranged to include every part of the authorized manual. In military mining on land each company should have one month's practice, including the construction and firing of mines charged with gunpowder and modern high explosives. In infantry drill and target practice each company should be exercised enough to maintain the reputation already acquired by the battalion in this necessary part of its duty.

In foot reconnaissance and military-map making all the non-commissioned officers and many selected privates should be thoroughly instructed. In military photography and the multiplication of maps in the field all the non-commissioned officers should receive regular instruction, which for men of special aptitude should be sufficiently extended to provide each company with skillful artisans to perform this work in war.

The practice in simple reconnoitering and surveying and in the use of the barometer already carried out should be continued not only for its own utility, but also to train the men in intelligence, and in manual dexterity in the use of instruments which their field duties often demand.

As the object of this organization is to obtain a complete system of instruction, it is suggested that if the foregoing meet with approval, such approval be given, with the understanding that changes may be made from time to time by the Chief of Engineers, with the approval of the Secretary of War.

I have also the honor to recommend that there be prepared at Willets Point, under the direction of the Board of Engineers, a torpedo manual, which will present the practical method of loading and anchoring torpedoes, making all electrical connections, and firing both single mines and groups. This manual should give a concise description of all boats and machinery for planting torpedoes with expedition, and the whole subject of the torpedo system should be condensed in a course of instruction similar in scope to the drill for pontoniers.

The object of this manual is, without betraying anything which in the judgment of the Chief of Engineers it is important to keep secret, that officers and even intelligent non-commissioned officers who have been through the school of instruction may be enabled to plant the torpedoes both singly and in groups, and to manipulate them efficiently and skillfully.

In connection with the researches at Willets Point, the commandant should from time to time inform the Board of Engineers for Fortifications, through the Chief of Engineers, of every new discovery or invention of this character, in order that the Board may be able to use such information in preparing the system of defense for various harbors throughout the United States.

I am, sir, very respectfully, your obedient servant,

JOHN NEWTON,
Chief of Engineers,
Brig. and Bvt. Maj. Gen., U. S. A.

Hon. ROBERT T. LINCOLN,
Secretary of War.

APPENDIX B.—COURSE OF WINTER INSTRUCTION.

[Printed Orders No. 9.]

BATTALION OF ENGINEERS,
Willets Point, New York Harbor, November 23, 1885.

I. Officers of the Battalion who have not already submitted the reports and papers required by Printed Orders No. 3, current series, will forward them at once.

II. The following course of winter instruction at the Engineer School of Application of the United States Army, recommended by the academic staff and approved by the Chief of Engineers, is ordered by the commandant for the ensuing season beginning on the 30th instant.

There will be two stated examinations of Engineer officers, conducted by the academic staff—one at the end of January, and the other at the end of April. The monthly examinations of the annual artillery detail will be held as required by existing orders.

SUBMARINE MINING.

The laboratory course (from December to April inclusive), under the supervision of the commandant, is placed under the special charge of the captains of the academic staff; one of them in weekly rotation will be in command of the buildings and of the details of officers and enlisted men.

Engineer officers studying the course are divided into two classes—those of the first and those of the second winter of duty with the Battalion. The first examination covers Part I of the Torpedo Manual. omitting Chapter IV, and includes a set of observations and measurements prescribed therein, the notes of which will be submitted to the staff.

The second examination covers in addition Parts II and III of the Manual, and every practical detail of the duty of electrician in setting up his apparatus, making the tests, etc. Samples of all mechanical work described in the Manual must be executed personally by each officer and submitted at this examination.

The third examination, in addition to the above, covers both parts of the report upon the experiments and investigations conducted at Willets Point to develop our system of submarine mining.

The fourth examination, in addition to the above, covers the professional papers of the school, treating of submarine mining, together with a full discussion of foreign systems as described in the writings of Stotherd, de Sarrepont, Van de Welde, Sleeman, and others, in the library of the torpedo laboratory.

The roster for the coming season will be arranged to give each officer 14 weeks for his first winter of service with the Battalion, 7 weeks for his second, and 6 weeks for his third winter.

Officers will proceed to the laboratory at guard-mounting daily, except on Saturdays and Sundays, and will remain there not less than six working hours.

The instruction roster of non-commissioned officers, arranged in regular rotation, will be kept by the adjutant. The details of privates will be made from the companies in turn. These details will spend the regular fatigue hours daily, Saturdays and Sundays excepted, at the laboratory for enlisted men. Every soldier not excused by orders will be included on this list, but the roster will be arranged specially for the benefit of the recruits. Their instruction will be directed by the captain in charge, who will be assisted by the senior lieutenant on the detail.

Instruction will comprise telegraphing with the dial instrument, including the code for action; the duties of the loading-room, and, so far as practicable, of the boat service as prescribed in the Torpedo Manual—comprising preparing the plugs of the buoyant and ground torpedoes; charging the mines; charging the cut-off boxes, three methods; jointing the cores; making turk's heads in the electrical cable; using the junction boxes; attaching a cable stop; splicing and knotting hemp rope; inserting thimbles in the wire mooring rope. They will also receive from the commissioned officers ***daily verbal instruction*** respecting the fuses, explosives, torpedo material (except that of the operating room), voltaic batteries, simple electrical testing, and the use of the portable apparatus for the electrical ignition of mines. On the Saturday terminating his tour, the captain in charge will submit a report giving the names and proficiency of the detail, what *verbal* and other instruction they have received, and figures showing the insulation of the core joints made by them. Printed blank forms will be supplied.

CHEMISTRY AND MILITARY PHOTOGRAPHY.

The building, apparatus, chemicals, &c., are in charge of the Battalion quartermaster.

Officers detailed for instruction will proceed to the photographic laboratory at guard-mounting daily, Saturday and Sunday excepted, and spend not less than six hours there on duty. Officers not on the roster may, at their option, use the laboratory on Saturdays, and on such other days as will occasion no confusion or overcrowding.

The course of instruction will be arranged to cover, (1) making negatives with gelatine emulsion plates, including the preparation of developers, intensifiers and other solutions; (2) silver printing, including the preparation of all necessary solutions, finishing and mounting the prints; (3) map printing, including the preparation of glass and paper negatives, the blue process, &c.; (4) photolithography, including the preparation of the negatives by the wet-plate process, the preparation of the prints, the transfer to the stone or zinc plates, and the mechanical process of printing.

Each officer who has made a survey will submit a dozen copies of it prepared in this manner; (5) miscellaneous work, such as the heliotype process, &c.

At the close of each weekly tour, each officer of the detail will submit, through the Battalion quartermaster, a personal report upon the work he has accomplished; and at the close of the season a set of pictures made by himself. Printed blanks for the weekly reports will be supplied.

Five non-commissioned officers from each company in turn will be detailed for instruction for one week, Saturday and Sunday excepted. Attendance will include the usual fatigue hours.

MILITARY ENGINEERING.

The examination in this course will be held at the end of April.

Engineer officers studying this course are divided into two classes—those of the second and those of the third winter of service with the Battalion. The roster will be arranged to give the former 7 weeks and the latter 3 weeks of instruction.

For the second winter the course will be such portions of the following works as may be designated by the academic staff: Hamley's Art of War; Clark's Coast Defense; Vol. VII, Professional Papers, Corps Royal Engineers; Very's Development of Armor for Naval Use; Tidball's Heavy Artillery Tactics; Gun Foundry Board Report; Griffin's Monograph; Professional Paper No. 25, Corps of Engineers, U. S. A.; Fortifications of to-day; Report of Board of Engineers, 1883; U. S. Fortifications, Report of Chief of Engineers, 1882; Woolwich Text-Book; Abbot's Hasty Notes.

For the third winter the course will be the remaining parts of Hamley and a review of the second winter's course.

CIVIL ENGINEERING.

The examination in this course will be held at the end of April.

The course will be 11 weeks for officers serving their third winter with the battalion, and will constitute such portions of the following works as may be designated by the academic staff: Non-tidal Rivers, Janicke, &c., Merrill; Rankine's Civil Engineering; Lake Survey Report, Professional Paper, Corps of Engineers, No. 24; Hydraulic Gates and Dams; Jackson's Hydraulics; Harcourt's Rivers and Canals, and Harbors and Docks; Johnson's Topographical Surveying; Treatise on the Steam Engine; Schlichting's Regulation and Canalization of Navigable Non-tidal Rivers (translation).

METEOROLOGY.

The usual meteorological observations at Willets Point will begin on January 2, 1886, and will continue for sixty consecutive days. Officers will make themselves familiar with the contents of Professional Paper No. 15 of the Corps of Engineers, treating of meteorology and barometric hypsometry.

The three captains, each acting for ten days in turn, are charged with the supervision of these observations.

The observers will consist of the lieutenants on company duty with the Battalion at this post, and of the requisite number of non-commissioned officers from each of the three companies, to be selected by the captains. Each tour will consist of one day, during which time all reductions and plotting pertaining to their records will be made. Observations between the hours of 12 p. m. and 6 a. m., both inclusive, may be omitted. The roster of companies will be kept by the Battalion adjutant.

Immediately after the termination of the observations the data will be fully and intelligently discussed upon Colonel Williamson's system, by aid of the daily plots and diagrams, and under the supervision of the captains, by the lieutenants of the companies. *Reduction to second level will be omitted.*

To Company B is assigned the reduction of the observations with the psychrometer, including force of vapor and relative humidity; to Company C, those with the aneroid barometer and of the air temperature, and to Company A those with the mercurial barometer, and of the winds and clouds.

INFANTRY DRILLS.

Company commanders will see that their companies are kept well drilled in the manual of arms, and that they are practical in the bayonet exercise, gallery target practice, and, *when the weather is suitable*, in estimating distances. The hours of practice and of recruit drills will be regulated as may be most convenient. One company drill will be had at 3 p. m. by Company A on Wednesday, by Company B on Thursday, and by Company C on Friday of each week, recall being sounded at 2.30 p. m. for that purpose. The drill will be attended by all men except the foregoing details and men excused by orders.

RECITATIONS OF ENLISTED MEN.

The non-commissioned officers of each company in turn will, unless excused by orders, be detailed for one week for theoretical instruction. They will be excused from all duties but those necessary in the company. Recitations will be conducted daily (Saturdays and Sundays excepted) under the supervision of the company commanders.

Regular classes will be formed in field fortification (including mining), pontoniering, topographical drawing, infantry tactics, the theoretical and practical use of the railroad transit, military signaling, and submarine mining according to the three parts of the Manual. The instruction in electricity will include verbal explanations and experiments in the electrical laboratory. Each recitation will be marked on the West Point system, and at the close of each week a list showing the marks of each non-commissioned officer, in each branch, will be forwarded to the commandant.

A school for soldiers will be established as prescribed in the Regulations of the Army. Attendance will be voluntary, the object being to extend aid to such enlisted men as desire to devote a portion of their winter's leisure to study. This school will be under the charge of the Battalion adjutant. Sessions will be held between 7½ and 8½ p. m. on Tuesdays, Thurdays, and Fridays of each week. Weekly reports of progress will be rendered.

III. The following is a consolidated roster for the officers of Engineers taking the course above ordered. The letters T, P, M, and C denote submarine mining, photography, military engineering, and civil engineering, respectively. No exchanges on this roster will be allowed, and no exchanges on other rosters, except upon written applications forwarded through company commanders:

CONSOLIDATED ROSTER FOR OFFICERS.

Week beginning—	Company A.					Company B.				Company C.			
	Lieut. Spencer.	Lieut. Waterman.	Lieut. Sanford.	Lieut. Gaillard.	Lieut. Craighill.	Lieut. Zinn.	Lieut. Chittenden.	Lieut. Taylor.	Lieut. Kuhn.	Lieut. Langfitt.	Lieut. Hale.	Lieut. Gillette.	Lieut. Sibert.
November 30	T	C	......	T	P	C	T	......	T	C	T	......	P
December 6	C	C	P	......	T	T	......	M	T	C	P	T	......
December 13	C	......	T	P	T	......	M	T	P	T	......	M	T
December 20	C	T	M	T	......	C	T	P	T	......	T	P	M
December 27	T	C	M	......	T	C	P	......	T	C	......	T	P
January 3	......	C	T	P	T	T	M	T	......	C	M	......	T
January 10	C	C	......	T	P	C	T	M	T	T	T	M	......
January 17	C	T	P	......	T	C	......	M	T	C	P	T	M
January 24	C	......	T	P	T	T	M	T	......	C	M	P	T
January 31	T	C	M	T	......	C	T	P	T	C	T	M	......
February 7	C	T	......	M	T	C	P	......	T	......	M	T	P
February 14	......	C	T	P	T	C	......	T	P	T	......	M	T
February 21	T	M	M	T	P	......	T	P	T	C	T	......	M
February 28	M	M	P	M	T	T	M	M	T	C	P	T	M
March 7	M	M	T	M	T	M	M	T	P	T	M	M	T
March 14	M	T	M	T	......	M	T	P	T	M	T	P	M
March 21	T	C	M	M	T	M	P	M	T	M	M	T	P
March 28	C	C	T	M	T	T	M	T	P	M	M	M	T
April 4	C	C	M	T	P	C	T	M	T	T	T	M	M
April 11	C	T	P	M	T	C	M	M	T	C	P	T	M
April 18	C	C	T	M	T	C	P	T	......	C	M	P	T

The weekly detail of enlisted men for instruction in submarine mining will consist of 5 sergeants, 9 corporals, and 60 privates, or as nearly these numbers as the exigencies of the service will permit.

The recitations of the school for soldiers will be held in the evening in the new torpedo drill building. Company recitations of non-commissioned officers may be held in the same building, or in one or both of the rooms assigned to the post school for children, at the option of the company commanders—provided, however, that such hours are selected as will not interfere with the regular use of these rooms.

IV. Unless otherwise ordered by the Superintendent of the Military Academy, the enlisted men of Company E will receive, so far as practicable, the same instruction as the rest of the Battalion; and a consolidated report of the recitations of the non-commissioned officers in each branch will be forwarded to the adjutant at the close of the season.

By order of Lieutenant-Colonel Abbot.

S. W. Roessler,
First Lieutenant of Engineers, Adjutant.

Appendix C.—Programme of Study and Instruction for Summer Season.

[Order No. 74.]

ENGINEER SCHOOL OF APPLICATION, U. S. A.

Willets Point, *New York Harbor, April 22*, 1886.

The following programme of study and instruction for the ensuing summer season, to commence May 3 and end November 27, 1886 (thirty weeks), having been recommended by the academic staff and approved by the Chief of Engineers, will be carried into effect accordingly.

MILITARY ENGINEERING.

1st. Verbal instruction by the company officers in the nomenclature and dimensions of the siege battery. 2d. Instruction in the molding room, including the making of modern siege batteries and saps, to scale. This drill will be by company, each in turn being entitled to the use of the room for one month. A commissioned officer of the company must always be present. 3d. A full course of trestle and wooden ponton drill, including both maneuvers. 4th. The preparation and firing of a military mine by each company. 5th. Infantry tactics, including the school of the soldier and of the company. Battalion drills will be had under the direction of the Battalion commander, each captain being occasionally detailed to command at a drill. 6th. Target practice under the authorized system. A commissioned officer will supervise all firing. 7th. Military map making. Each lieutenant on company duty who has not already done so, and each non-commissioned officer and as many selected privates from each company as practicable, will make a satisfactory foot reconnaissance at least five miles long in the vicinity of the post. The instructions laid down in General Orders No. 12, series of 1885, from these headquarters, will be strictly followed, including the contouring. Especial attention will be given to *making the scales correctly*; (1) no attempt being made to change the natural length of step in the field work; (2) the plot being made in terms of this natural unit; (3) its absolute length being determined carefully by pacing several times over a known distance; and (4) a correct scale being constructed from these data, with 100 yards as the unit, the zero being between the first and second divisions on the left, and the first division being subdivided into ten equal parts. The plot will distinctly show the *beginning and end of the reconnaissance*, without any attempt at compromising discrepancies.

The captains will submit to these headquarters, on or before the termination of the season, the several maps and drawings, each duly approved by themselves.

SUBMARINE MINING.

A weekly detail of two lieutenants—not from the same company—will be made, who will spend seven hours daily on this duty (Saturday and Sunday excepted). They will be excused from all other duties except dress-parades and inspections. The artillery officers will be included in the above detail. The other company commanders and the Battalion staff officers will occasionally be detailed to relieve the officer in charge in the duty of supervising these drills. Weekly details will be made of not less than two non-commissioned officers and of twelve privates from the companies not on the roster for special drills in military engineering, for one week.

In the absence of commissioned officers Sergeants William H. Brown, Company A, and Henry Warner, Company B, assistant instructors in submarine mining, will be in general charge of this detail. During fatigue hours (except on Saturday and Sunday) the men will be instructed (1) in the duties of the boat service connected with submarine mines, and (2) in those of the loading room. The following system will be observed as closely as circumstances permit.

1st. Monday. *Judgment torpedo drill.*—The mapping drill will first be practiced; then the judgment firing drill. A few steamers or sailing vessels should be tracked at every drill, and the diagrams will be neatly finished and preserved.

2d. TUESDAY. *Placing the junction boxes.*—This drill will be simulated on land until the principles are fully understood by every member of the detail. It will then be executed on the river, using the base line between the fort and Engineer Wharf. Care must be taken, by providing buoy ropes of sufficient strength, to avoid the loss of anchors.

3d. WEDNESDAY. *Planting a group of mines.*—One officer will act as electrician, and the other will command on the steam launch; the former, on Monday or Tuesday, will set up the apparatus completely in the mining casemate, so that everything shall be in readiness. All the tests used in planting a grand group will be made. Before the officer's detail is relieved, it will remove all the apparatus from the mining casemate, unless otherwise ordered.

4th. THURSDAY. *Automatic firing drill.*—This drill must first be practiced at the wharf, in the manner prescribed in the manual. Subsequently it may be combined with the judgment drill on the river.

5th. *Daily instruction in rowing.*—This drill (weather permitting) will be under the direction of Lance-Corporal Lane, Company C, assistant instructor in submarine mining, and will be had between morning fatigue call and 8.30 a. m.

6th. In unfavorable weather, the detail will be exercised in the duties of the loading-room, in the shore duties pertaining to the boat-service, and in the use of the dial telegraph; and verbal instruction will be given respecting the fuzes, explosives, torpedo material (except that of the operating room), simple electrical testing, and the practical use of the ordinary forms of apparatus for the electrical ignition of mines. This may be done in the enlisted men's laboratory, by reading and elaborating portions of the text of the manual.

On each Saturday the officer in charge will submit the plots of the mapping drills, and a report giving the names of the enlisted men; what they have been drilled in, and their classification as to proficiency; printed blank forms will be supplied. Also personal reports from each officer showing what he has accomplished, with notes of his tests, and a statement of any difficulty encountered, and any suggestion he may desire to make.

CIVIL ENGINEERING.

The following instrumental surveys will begin at once, and officers will be excused from all other duty when detailed for this purpose. The detail will be made by the adjutant, if officers are available, upon the application of the officer in charge from companies on no special roster in military engineering. Each lieutenant on company duty who has not already done so will make and plot a careful instrumental survey of at least 1 square mile of ground. The work will include contours with a surveyor's level. He will be assisted in the field work by details of non-commissioned officers and privates from his company. The work will be plotted on a scale of 12 inches to the mile, with contour planes 10 feet apart, and may be executed upon any recognized system preferred by the officer. Good level bench marks should be made and located on the map, the references being given in a column of notes. The name of the residents should be recorded. A field azimuth of one of the lines will be determined astronomically. The finished maps will be submitted on or before the termination of the drill season.

A careful hydrographic survey of at least one-quarter of a square mile will be made by the lieutenants on company duty, if practicable.

Current measurements will be taken by the electric current meter, and with double floats, by officers serving their second year with the Battalion, and will include a full set of observations and a discussion of the same.

FIELD ASTRONOMY.

All the lieutenants who have not already completed the course, and been excused from further observations, will constitute the observers, being called upon by the officer in charge as wanted. In addition, when officer of the day (except on Sundays), the weather permitting, they will observe the sun for time. These observations will be computed at once in the book prepared for the purpose, and the error of the mean solar chronometer will be distinctly recorded there and on the guard report where, in case no observations are taken, the cause should be stated.

The following system will govern the observations at the observatory. The course covers two seasons, the first including sextant work, and transit and zenith telescope work, with the instruments in the east wing and on the outer pier, and the second including sextant work, practice with the new combined instruments in the west wing, and with the equatorial. Advantage will be taken of every suitable night for observing. Officers wishing to use the instruments for special observations or practice must apply for authority to do so.

Special note books will be provided for each officer, which, after the end of the season, and inspection by the commanding officer, will become his personal property.

Suitable blank forms will be printed, both for observations and computations, and these original records will be pasted into the books, thus rendering them valuable for future reference.

The following allowance of time will be made for computations. Three days for a set of latitude observations with the sextant, for a set of time observations with the transit, for a longitude by Jupiter's satellites, for the value of a level division or for a micrometer turn with the zenith telescope. Ten days for a longitude by moon culmination, or by lunar distances, or by an occultation by the moon, or for latitude by the zenith telescope. These limits as to time must be strictly observed, or daily reports will be submitted in writing to the instructor explaining the reason of any delay. The following will be the ordinary routine of observations with the several instruments.

Sextant.—After becoming skillful in the use of this instrument upon the sun, observers will deduce at least one satisfactory latitude by observing a north and a south star, using the time deduced from an east and west star, each based on ten altitudes taken on the same night. These observations for latitude and time must be made near the observatory, and the time results must be reported for the Luken's chronometer. *No other record will be accepted.* The results will be reported to the officer in charge, and the work done under his direction.

Transit.—A set of time observations for rating the chronometer will be made about once a week, observing a star above and a star below the pole for deviation, and about five south stars for time. Occasionally an observation on a slow circumpolar star will be made for determining the collimation constant. Every moon culmination occurring before 1 a. m. will be observed, until each officer has secured at least one satisfactory result. At first the observer will take his own time, afterwards the chronograph will be used.

Zenith telescope.—Observers will first determine the level correction by daylight, using a distant terrestrial object, or at night using a slow circumpolar star. They will then find the value of a turn of the micrometer by observing Polaris at elongation. Lastly, they will observe for latitude, until they have obtained a satisfactory determination based on three nights' work upon not less than twenty pairs.

Equatorial telescope.—Every practical occultation of a star of the sixth or higher magnitude by the dark limb of the moon will be observed, either with this instrument or with an astronomical telescope, until each officer serving his second year has obtained one satisfactory result. Suitable lists will be prepared in advance so that no opportunity may be lost.

Personal equation machine.—Each officer will occasionally take a set of observations (80 to 100 transits) to determine his personal equation. This work will be done on cloudy nights (see Battalion Order No. 3, series of 1882, for form of record.)

Astronomical azimuth.—Each officer serving his second year will determine an astronomical azimuth accurately—using a large theodolite for the purpose. The results will be reported in a shape for publication.

MILITARY PHOTOGRAPHY.

The officers' laboratory will be open daily from 1.30 p. m. until 4 p. m. The building, apparatus, chemicals, &c., will be under the charge of the post quartermaster, whose duty it is to furnish any desired assistance, and who will be held responsible for the judicious use of the property. Officers are invited to avail themselves of the advantages of the laboratory, making such arrangements with the officer in charge as shall insure no confusion in his official duties, or in those of the men under his instruction. The instruction of enlisted men will be restricted to one from each company, selected from those having special aptitude. They will be detailed singly, for one week at a time, and will receive such instruction as, in the judgment of the officer in charge, is best suited to perfect their knowledge of the subject.

By order of Lieutenant-Colonel Comstock.

S. W. Roessler,
First Lieutenant of Engineers, Adjutant.

Appendix D.—Assignments to Charge of Departments of Instruction.

[Orders No. 83.]

Engineer School of Application, U. S. A.,
Post at Willets Point, New York Harbor, April 30, 1886.

The following assignments to the charge of departments of instruction are announced. At the close of the season each officer will submit a report upon the work done in his department, with any recommendations he may desire to make.

Military engineering, Maj. W. R. King,
Submarine mining, Capt. J. G. D. Knight.
Civil engineering, Capt. J. G. D. Knight, temporarily.
Practical astronomy, First Lieutenant S. W. Roessler, temporarily.
Military photography, First Lieutenant J. L. Lusk.

I. Daily drills in infantry will commence on the 3d proximo, and will be continued (Saturdays and Sundays excepted) until July 1st. The Battalion commander will order such additional recruit drills in infantry as may in his judgement be necessary.

The regular target practice season will be the months of May, June, July, and September, under the direction of the Battalion commander.

In engineering there will be daily drills, Saturdays and Sundays excepted.

Ponton exercises for Company A in May, for Company B in June, and for Company C in July, will be devoted to drills on land, including building trestle bridges, loading the wagons, and putting together the canvas boats; those for Company A in August, for Company B in September, and for Company C in October, will be devoted to drills on the water, including the construction of bridges and boat maneuvers. After the pontons are put in the water, captains may order such exercises in rowing in the morning as they think expedient.

Instruction in field fortification and the saps, will be given in the molding room—for Company A in June, for Company B in July, and for Company C in August.

Practice in military mining will be given on the glacis of the old land front—for Company A in June, for Company B in July, and for Company C in August.

This programme leaves November unassigned, and also three months for each company (Company A, July, September, and October; Company B, May, August, and October; and Company C, May, June, and September). During these months all torpedo and fatigue details will, if practicable, be taken from the companies off duty; and the spare time will be devoted to surveys, practice in military map-making, and preliminary target practice and range firing.

By order of Lieutenant-Colonel Comstock.

S. W. ROESSLER,
First Lieutentant of Engineers, Post Adjutant.

APPENDIX E.—WATER SUPPLY, SEWERS, HOSPITAL ACCOMMODATIONS.

Proceedings of a Board of Officers convened by virtue of the following order:

SPECIAL ORDERS } No. 187. }

HEADQUARTERS OF THE ARMY,
ADJUTANT GENERAL'S OFFICE.
Washington, August 17, 1885.

[Extract.]

1. By direction of the Secretary of War, a Board of Officers, to consist of—
Col. Quincy A. Gillmore, Corps of Engineers,
Lieut. Col. Henry G. Hodges, Deputy Quartermaster-General, U. S. Army,
Maj. David L. Huntington, surgeon, U. S Army,
will assemble at Willets Point, New York, upon the call of the senior member, at suc time as the duties of the members will permit, to examine into and report upon th question of source and method of water supply, and of sewers and proper hospital accommodations at that post.

The junior member of the Board will act as recorder.

The report of the Board will be forwarded, through the Chief of Engineers, to th Adjutant-General of the Army.

Upon the final adjournment of the Board, the members will rejoin their prop stations.

The travel required under this order is necessary for the public service.

* * * * * * *

By command of Lieutenant-General Sheridan.

R. C. DRUM,
Adjutant-General.

WILLETS POINT, N. Y., *September* 3, 1885.

In accordance with the above order, the Board met at Willets Point on the abov date at 12 o'clock m.

Present: All the members.

After a careful inspection of the post, with reference to the points indicated in th above order, the Board adjourned to meet in New York City to consider their report

NEW YORK, *September* 7, 1885.

The Board met according to adjournment.

Present: All the members. And respectfully submits the following report, premising that the recommendations made upon water supply and sewerage must be regarded as preliminary and dependent upon the experiment now in progress at Willets Point, which will be adverted to below.

SOURCE AND METHOD OF WATER SUPPLY.

The Board finds that the present water supply is derived from surface wells located at different points within the reservation.

The opinion of the Board is that the quantity of water supplied from these sources is entirely inadequate to the comfort of the garrison for ordinary sanitary purposes and for protection against fire.

From the evidence submitted to the Board there is no reason to believe that the quality of the present supply is positively impure, but it is certain that in time these wells must be contaminated by their close proximity to habitations, gardens, privies, and stables.

It is, therefore, in the opinion of the Board, imperative that the water supply shall be derived from sources free from all suspicion of pollution, and in quantity sufficient to meet all the necessary requirements of the post. Moreover, the troops of the garrison should be relieved from the severe duty of distributing water by the almost obsolete system of water wagons and barrels.

FLUSHING WATER SUPPLY.

From evidence presented to the Board, it is their opinion that the system of water supply now in use by the city of Flushing, L. I., cannot be relied upon for the use of this post, it being understood that the present sources of supply are regarded as impure, and in quantity deficient.

INDEPENDENT SPRINGS.

The Board examined a certain spring, or cluster of springs, discharging within the fort, and find the water pure and potable, but in their opinion of insufficient quantity to satisfy the ordinary demands of the garrison. In case of emergency, it is probable that this supply could be relied upon to furnish water for drinking and cooking purposes for a limited time.

ARTESIAN WELL.

The experiment looking to a full supply of good water by the artesian system is now in progress, the boring having reached a depth of over 300 feet, and will be continued at least 500 feet deeper, if necessary. It is hoped that the result of this experiment will be a plentiful supply of potable water, and in quantity sufficient for all possible demands. Should this prove to be so, the problem of water supply is happily solved.

The Board is unanimously of the opinion that this work should be continued until a satisfactory result is reached, or until it becomes manifest that no supply can be obtained.

If the Artesian experiment fails, it is the opinion of the Board that a sufficient supply may be obtained from surface wells sunk in such localities upon the reservation that all possibility of pollution may be avoided.

It is the opinion of the Board that not less than 60,000 gallons of water a day will be needed to properly supply the demands of the garrison. This estimate is based upon an allowance of 100 gallons per head per diem for a population of 600 individuals. Should it be found impracticable to obtain this quantity, the Board is of the opinion that any amount which may be secured below this estimate should be reserved exclusively for domestic purposes, and that a cistern of sufficient capacity to store 250,000 gallons of rain water, gathered from the roof of the molding building, should be constructed near that building, to be held in reserve for all possible emergencies arising from water famine, fire, and for police purposes. A cistern of this capacity is required to avoid the necessity for using the water from what is known as the "ice pond," a small sheet of impure water surrounded by sources of pollution. In view of its quality and the necessity of draining it for sanitary reasons, it is earnestly recommended that no use whatever be made of this water.

In this connection the Board is of the opinion that the post should be provided with steam fire engine for such emergencies as may arise.

With regard to the method of distribution of the water when obtained, the Board of the opinion that the water should be delivered from its sources into a properly constructed reservoir or stand-pipe, and thence distributed by mains over the garrison, provision being made for connecting with quarters and barracks, and for furnishing a sufficient supply for domestic purposes, bath-rooms, and water closets.

Provision should also be made to place hydrants at points convenient to the quarters, barracks, hospitals, and store-houses of the post.

SYSTEM OF SEWERAGE.

There is at present no system of sewerage at the post. Earth-pit privies are provided for the quarters and all other buildings except the barracks. Closets for the accommodation of the enlisted men are placed over the water, below high-water mark, but are inconvenient on account of their distance from the barracks. Refuse from the kitchens is removed in barrels for final disposition.

After a due consideration of the subject of a *general* sewerage, the Board believes that the plan recommended by a board of officers convened at Willets Point to examine into and report upon this subject is as well adapted to the purposes required as the nature of the ground will admit.

With regard to the *particular* system which should be adopted at this post, the Board is inclined to recommend the separate system as preferable for the purposes of this garrison, but as the result of the present experiment, having in view the obtaining of a proper water supply, must largely influence the decision for one or another system, it is deemed better to make no further recommendation upon this subject at present, reserving a full expression of views for a supplementary report.

Inasmuch as the cost of distributing water and supplying sewerage will be substantially the same for either source of supply or system of sewerage disposal, estimates are herewith appended.

* * * * * * *

The Board desires to express its acknowldgments for much valuable information upon the points under discussion derived from a report by a Board of officers convened to meet at Willets Point, October 21, 1884, to report upon the present water-supply at the post, &c., by order of Lieutenant-Colonel Abbot, commanding the post.

Appended to this report will be found—

I. An estimate for constructing storage cistern near model building.
II. An estimate for engine-house, steam pumps, and reservoir for water supply.
III. An estimate for iron pipes, labor, &c., for water supply.
IV. An estimate for labor and material for sewerage system.

* * * * * * *

ESTIMATES.

For constructing storage cistern near model building, for possible contingencies arising from water famine, fire, and for police purposes	$3,875
For steam pumps and boiler, engine-house, pipes, and distributing reservoir.	20,000
For 9,000 feet of iron mains, at 67 cents	6,000
For 20 hydrants, at $50	1,000
For labor on mains and hydrants	3,000
For labor and material for system of sewerage and house plumbing	12,000

* * * * * * *

There being no further business before the Board, it adjourned subject to the call of the senior member.

Q. A. GILLMORE.
Colonel of Engineers, Brevet Major-General, U. S. A., Senior Member.
HENRY C. HODGES,
Lieutenant-Colonel and Deputy Quartermaster-General, U. S. A.
DAVID L. HUNTINGTON,
Surgeon, U. S. Army, Recorder.

The ADJUTANT-GENERAL OF THE ARMY.
(Through the Chief of Engineers.)

APPENDIX F.—PLAN AND ESTIMATE FOR BRICK BARRACK.

ENGINEER SCHOOL OF APPLICATION,
WILLETS POINT, N. Y., *March* 10, 1886.

GENERAL: In compliance with your instructions of July 6, 1885, I have the honor to transmit herewith a drawing of a brick barrack for a full company of engineer soldiers (10 sergeants, 10 corporals, 2 musicians, 64 first-class privates, 64 second-class privates), 150 enlisted men.

Beds for 152 corporals and privates are indicated on the drawing—the sergeants are quartered in the small rooms (10). This gives a surplus of 12 beds. Allowing for men living outside of barracks—married soldiers, quartermaster room near stable, watchmen in separate building, &c.—provision is thus made for having one large barrack room without beds, for use as an amusement room and company formations in inclement weather.

Ventilation has received special attention. Each man is allowed 600 cubic feet, and, as shown on the drawing, fresh air is admitted under the stoves, and a ventilating shaft is provided. The kitchens are in the separate building now occupied as such, thus avoiding the heat and smells of cooking in the barracks.

The following estimate has been carefully made upon the basis of current prices. It contemplates constructing the buildings on the present sites, where foundations now exist. The first building erected will probably be placed elsewhere, to prevent putting the company in camp, and if so the estimate should be increased, say, $25,000. A brick barrack for a light battery (65 men) is now under construction at Fort Hamilton at a contract price exceeding $18,000, and the plan, in my judgment, is much less suited to our needs than that herewith submitted.

ESTIMATE FOR ONE BARRACK, 150 MEN.

Masonry in walls	$6,310
Repairing foundations	1,000
Plastering	1,800
Floors	1,718
Windows and doors	1,480
Roof	2,900
Stairs	500
Veranda	1,920
Painting	1,000
Contingencies (say)	4,372
Total	23,000

In reply to the latter part of your instructions of July 6, 1885, I will say that the present barracks were put in good repair last autumn and that they are reported to me as entirely comfortable even during the recent severe weather. The officers' quarters were also repaired and supplied with new heaters, of larger size than those in use before; and no complaints of discomfort are made this season (except in the old mess building, quite unfit for occupation, for which an appropriation has been asked from Congress).

Very respectfully, your obedient servant,

HENRY L. ABBOT,
Lieut. Col. of Engineers, Bvt. Brig. Genl.

The CHIEF OF ENGINEERS,
Washington, D. C.

APPENDIX No. 2.

BATTALION OF ENGINEERS AND DEPOT AT WILLETS POINT.

REPORT OF MAJOR W. R. KING, CORPS OF ENGINEERS, OFFICER IN COMMAND, FOR THE FISCAL YEAR ENDING JUNE 30, 1886.

BATTALION OF ENGINEERS AND DEPOT,
Willets Point, New York Harbor, August 14, 1886.

GENERAL: I have the honor to submit the following report on the Battalion of Engineers and Depot of Engineer property at Willets Point for the year ending June 30, 1886.

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

I.—BATTALION OF ENGINEERS.

The law provides for five companies of Engineer troops, having an authorized maximum strength of 752 enlisted men, officered by details from the Corps of Engineers. At present only four companies, with a total strength of 450 enlisted men, are allowed to be recruited.

The aggregate strength of the Battalion June 30, 1886, was 17 commissioned officers and 396 enlisted men.

During the past year companies A, B, and C have been stationed at Willets Point; Company D exists only in name; Company E has been stationed at West Point to assist at the practical instruction of cadets of the Military Academy, in building military bridges, sapping, mining, and signaling.

The following is a roster of officers serving with the Battalion June 30, 1886:

Maj. W. R. King, Corps of Engineers, commanding.
First Lieut. S. W. Roessler, Corps of Engineers, adjutant.
First Lieut. J. L. Lusk, Corps of Engineers, quartermaster.

Company A.

Capt. J. G. D. Knight, Corps of Engineers, commanding company.
First Lieut. H. E. Waterman, Corps of Engineers, with company. On temporary duty at Sandy Hook.
Second Lieut. D. duB. Gaillard, Corps of Engineers, with company.
Second Lieut. W. E. Craighill, Corps of Engineers, with company.

Company B.

Second Lieut. H. M. Chittenden, Corps of Engineers, commanding company.
Second Lieut. H. Taylor, Corps of Engineers, with company.
Second Lieut. J. E. Kuhn, Corps of Engineers, with company.

Company C.

First Lieut. W. C. Langfitt, Corps of Engineers, commanding company. On temporary duty at Sandy Hook.
Second Lieut. I. Hale, Corps of Engineers, in temporary command of company.
Second Lieut. C. E. Gillette, Corps of Engineers, with company.
Second Lieut. W. L. Sibert, Corps of Engineers, with company.

Company D.

First Lieut. S. W. Roessler, Corps of Engineers, commanding company.

Company E.

Capt. P. M. Price, Corps of Engineers, commanding company.
First Lieut. J. G. Warren, Corps of Engineers, with company.
First Lieut. G. A. Zinn, Corps of Engineers, with company.

The following table shows the changes that have taken place in the personnel of the officers during the year:

Rank.	Names.	Date.	Joined or relieved.	Remarks.
Major	Stanton, W. S	Aug. 28, 1885	Relieved	Order No. 150, U. S. M. A., August 28, 1885.
Captain	Greene, F. V	Aug. 28, 1885	Joined	Do.
First lieutenant	Fitch, G. D	Sept. 26, 1885	Relieved	Special Order No. 189, A. G. O., August 19, 1885.
Second lieutenant	Kuhn, J. E	Sept. 30, 1885	Joined	Special Order No. 187, A. G. O., August 17, 1885.
Do	Craighill, W. E	Oct. 30, 1885	do	Do.
First lieutenant	Beach, L. A	Nov. 5, 1885	Relieved	Special Order No. 267, A. G. O., November 19, 1885.
Do	Black, W. M	Jan. 5, 1886	do	Order No. 3, U. S. M. A., January 5, 1886.
Do	Spencer, E. J	Jan. 7, 1886	do	Special Order No. 300, A. G. O., December 21, 1885.
Captain	Greene, F. V	Jan. 12, 1886	do	Order No. 10, U. S. M. A., January 12, 1886.
First lieutenant	Warren, J. G	Jan. 15, 1886	Joined	Order No. 12, U. S. M. A., January 15, 1886.
Second lieutenant	Sanford, J. C	Feb. 12, 1886	Relieved	Special Order No. 29, A. G. O., Febuary 4, 1886.
Lieutenant-colonel	Comstock, C. B	Mar. 18, 1886	Joined	Special Order No. 16, A. G. O., January 20, 1886.
Do	Abbot, H. L	Mar. 18, 1886	Relieved	Do.
Major	King, W. R	Apr. 26, 1886	Joined	Do.
Lieutenant-colonel	Comstock, C. B	Apr. 26, 1886	Relieved	Do.

Capt. P. M. Price was relieved from command of Company C and assigned to command of Company E, per Special Order No. 1, Adjutant-General's Office, January 2, 1886, and Order No. 12, United States Military Academy, January 15, 1886.

First Lieut. G. A. Zinn was relieved from duty with Company B in Special Order No. 31, Adjutant-General's Office, February 6, 1886, and assigned to duty with Company E in Order No. 30, United States Military Academy, in compliance with Special Order No. 31, Adjutant-General's Office, February 6, 1886.

Capt. Thomas N. Bailey died at Willets Point at 10.30 a. m. April 20, 1886.

RECRUITING.

During the past year the companies of the Battalion have been recruited partly by enlistments and re-enlistments at Willets Point and West Point, partly by the assignment of recruits from David's Island, and partly by special enlistment at a rendezvous of the general recruiting service in New York City.

The Engineer sergeant detailed under authority conveyed by letter from the Adjutant-General, United States Army, dated June 2, 1885, to recruit for the Battalion of Engineers at general recruiting service rendezvous, New York City, was relieved November 13, 1885.

Under authority conveyed by letter from the Adjutant-General, United States Army, dated May 24, 1886, another Engineer sergeant was detailed to report to the superintendent of the general recruiting service to recruit for the Battalion, 50 recruits being required to fill the Battalion up to the authorized number. He was attached to the rendezvous at No. 116 Chatham street, New York City, where he still remains, and the indications are that he will succeed in procuring the required number of good men.

The following is a summary statement of the recruiting, desertions, and other changes among the enlisted men of the Battalion during the past year:

Recruits from depot, New York City and David's Island		83
Enlisted in Battalion:		
Willets Point	30	
West Point	7	
		37
Re-enlisted in Battalion:		
Willets Point	30	
West Point	8	
		38
By transfer		1
From desertion		8
Discharged by expiration of service		38
Discharged for disability		8
Discharged by sentence of general court-martial		7
Discharged by order		15
Died of disease		4
Deserted		76

This last number, though large, is less than 70 per cent. of the corresponding number last year.

DUTIES AND INSTRUCTIONS.

At Willets Point the companies furnished the ordinary police guard and care for the property in store, as well as received and issued instruments, &c., used by officers in the field.

The Battalion is equipped and drilled as infantry, and performs regular garrison duty, target practice, &c., in addition to their special duties as sappers, miners, and pontoniers, and they have continued the experiments with explosives, fixed and movable torpedoes, electric exploders, and motors, including the transmission of power to a distance by electricity.

The course of instruction is defined in Battalion Orders No. 3, April 27, 1885,* Battalion Orders No. 9, November 23, 1885,† and Post Orders No. 74, April 22, 1886,† copies of which are herewith inclosed.

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* Appended hereto, p. 495.

† See Appendix No. 1, B and C, report of General Comstock, pp. 477 and 481.

The course is divided into two parts, viz, the summer season and the winter season. The former comprised a period of seven months, from May 1 to November 30, and was devoted to outdoor drills and exercises. The latter comprised a period of five months, from December 1 to April 30, and was devoted to indoor drills and theoretical instruction.

SUMMER SEASON.

Submarine mining.—A weekly detail of officers and non-commissioned officers received instruction and practice in the details of planting, operating, and raising a group of mines.

Practical engineering.—Each company received one month's instruction and practice in the construction of field fortification and saps to a reduced scale in the molding-room and in the construction and explosion of a land mine.

Ponton drills.—Each company received two months' instruction and practice in these drills, one month being devoted to drills on land, including building of trestle bridges, loading the wagons, and putting together the canvas boats; and one month to drills on water, including the construction of bridges and boat maneuvers.

Infantry drills, target practice, &c.—Daily infantry company drills were had during two months of the season and target practice for four months.

Military surveying.—Each officer on company duty who had not already done so has made and plotted an accurate topographical survey of at least one square mile of territory in the vicinity of the post. In addition, the non-commissioned officers and some selected privates have each made a foot reconnaissance of at least 5 miles in length.

WINTER SEASON.

Submarine mining.—During the winter season the instruction is mainly confined to the duties of the loading-room, in assembling all the parts of the torpedo. A weekly detail of officers and non-commissioned officers has received instruction in these duties.

Recitations.—The non-commissioned officers and a few selected privates of each company form a class for theoretical instruction, and during the winter recitations were held in submarine mining, infantry tactics, pontoniering, field fortifications, and signaling.

Meteorology.—Meteorological observations were continued for sixty consecutive days, commencing January 2, 1886. The officers on company duty and the non-commissioned officers constituted the observers.

TORPEDO EXPERIMENTS AT SANDY HOOK, NEW JERSEY.

Under instruction from the Chief of Engineers, U. S. Army, dated April 23, 1886, for testing the torpedo system, a grand group of mines was successfully planted in June, 1886, in the False Hook Channel, Sandy Hook, where the mines are exposed to the waves of sea and to blows from passing vessels. After remaining in position for about ten days the group was raised, except one triple group, which it is intended to keep in position until subjected to the test of a very heavy sea.

An officer and five men remain at Sandy Hook in charge of the group.

II.—ENGINEER DEPOT.

PUBLIC BUILDINGS AND CONSTRUCTIONS.

The building for instructing the enlisted men of the Battalion of Engineers in the theoretical knowledge of electricity and the practical operations of loading and testing submarine mines, junction boxes, &c., and in all the shore duties of the torpedo service, has been completed and was used during the past winter. The total cost was $5,562.24, $6,000 having been estimated for and allowed.

The building wherein are stored the buoyant torpedoes and materials pertaining to their service has been repaired and practically rebuilt, at a cost of $525.

A marine railway for hauling steamer David Bushnell out of the water for winter care has been completed, at a cost of $2,191.74; $3,000 estimated and allowed therefor. The ship-house for it has not yet been built. Instead of an inclosed building for the winter protection of the Bushnell, it will probably be as well to provide simply a light portable roof, which can be placed over her after she has been hauled out on the ways.

The large building (shed D) wherein are stored the wagons of the ponton train has been reshingled, at a cost of $686 90.

There is a valuable collection of models and war relics, which, for want of a better place, is stored in an old frame building, at such a distance from the torpedo laboratory that it is quite inconvenient for purposes of illustration and instruction, and I would respectfully recommend that suitable fire proof room—say 1,200 square feet of floor-space—be provided for this collection, either by an addition to the officer's laboratory building or by a separate building in the immediate vicinity.

There are in store nearly two hundred wooden ponton boats, which would never be used again in an active campaign, as they were built during the last war, and although some of them are in tolerable preservation, they can only be used safely for purposes of instruction. They now occupy considerable space, and the sheds under which most of them are stored were merely designed to prevent the sun's rays from warping and cracking the timber, and unless better shelter is provided they will soon be entirely destroyed. I would respectfully recommend that these boats be overhauled, and those of them worth repairing be placed under complete cover from rain and sun; the balance should be broken up, and the boards used for rough fencing, plank walks, or other purposes for which they are suited.

PROPERTY IN STORE.

The property in depot, consisting of the bridge equipage and stores for bridge, engineer, field, and torpedo service, also the astronomical, surveying, geodetic, drawing, electrical instruments, insulated cable, &c., for torpedoes, is stored and cared for.

WORK OF THE DEPOT.

The printing, draughting, photographing, lithographing, and binding, &c., have been done by Engineer soldiers, at a cost of $966.15 for extra-duty pay.

The printing and bookbinding has been useful to every department here. Confidential and professional books for the corps, reports, blank forms, orders, circulars, &c., have been made promptly and with economy.

The receipts and issues of instruments during the past year for the use of officers engaged in surveys and engineering work consisted of transits, theodolites, chronometers, sextants, barometers, chains, odometers, compasses, drawing instruments, &c.

A number of instruments were repaired during the year, at a cost of $1,337.25.

The instruments in depot are gradual accumulations of those that have been purchased by many different officers at widely different times and places, and are therefore of a miscellaneous character, many out of date and obsolete, which will not admit of interchange of parts for repairs by taking from unserviceable ones, and the general repairs when made are done by proposals from the lowest bidder, and it is difficult to detect faults which become apparent when they are subject to test in the field.

If some standard instruments could be decided on, to which all purchases for depot or field should conform, the usefulness of the depot to the general purpose for which it is intended, for storage, repair, and issue of instruments, would be much increased, and better satisfaction given to those receiving them, and greatly increase economy in service.

The number of really useful instruments cannot be judged from the returns, and is very much less.

III.—STATEMENT OF FUNDS.

Congress appropriated for the fiscal year ending June 30, 1886—

For instruction of Battalion, &c	$1,000
For incidental expenses of depot	3,000
For repair of instruments	2,000
Total	6,000

Of this there has been expended:

For instruction of Battalion, &c	$582 23
For incidental expenses of depot	2,105 72
For repair of instruments	1,337 25
Total	4,025 20

Of the appropriations for fiscal year ending June 30, 1887, the following sums have been assigned to me for disbursement, viz:

For incidental expenses of depot, &c	$3,000
For purchase of materials	1,000
For repair of instruments	2,000
Total	6,000

Which will be applied as contemplated by the law and projects made in accordance of the same.

There will be required for the fiscal year ending June 30, 1888:

For incidental expenses of depot, including fuel, lights, chemicals, stationery, extra-duty pay of soldiers necessarily employed as artisans on work in addition to, and not strictly in the line of, their military duties, such as carpentry, smithing, draughting, printing, photographing, lithographing, engine-driving, &c., and for repairs to public buildings and machinery, and unforeseen expenses	$7,000
For purchase of materials for instruction of engineer troops at Willets Point in their special duties of sappers, miners, and pontoniers, torpedo drill, and signaling	1,500

For purchase and repairs of instruments to be issued to the Corps of Engineers for use on public works, surveys, &c.	$2,500
For an additional building for storing and preserving the collection of engineer models and relics already referred to, so as to render the same available for purposes of illustration and instruction	8,000
In all	19,000

APPENDIX.—COURSE OF INSTRUCTION AND DRILLS, BATTALION OF ENGINEERS.

[Printed Orders, No. 3.]

BATTALION OF ENGINEERS,
Willets Point, New York Harbor, April 27, 1885.

The following will be the course of instruction and drills for the Battalion of Engineers during the coming season—beginning on May 4 and ending on November 30 (30 weeks).

UNITED STATES ENGINEER SCHOOL OF APPLICATION.

The following assignments to the charge of departments of instruction are announced. At the close of the session each officer will submit a report upon the work done in his department, with any recommendations he may desire to make.

Civil Engineering—Capt. J. G. D. Knight.
Submarine Mining—Capt. Philip M. Price.
Practical Astronomy—Capt. Thomas M. Bailey.
Military Photography—First Lieut. James L. Lusk.
Military Engineering—Each captain for his own company.

The following will be the course of instruction in the several departments.

MILITARY ENGINEERING.

1st. Verbal instruction by the company officers in the nomenclature and dimensions of the siege battery and model fronts of fortifications, including the reasons therefor. 2d. A course of instruction in the molding-room, including the making of modern siege batteries and saps upon a scale of 1 : 6. This drill will be by company, each in turn being entitled to the use of the room for one month. A commissioned officer of the company must always be present. 3d. A full course of trestle and wooden ponton drill, including boat maneuvers. 4th. The preparation and firing of a military mine by each company. 5th. Infantry tactics, including the school of the soldier and of the company. Battalion drills will be had under personal command of the lieutenant-colonel commanding; each captain being occasionally detailed to command at a drill. 6th. Target practice under the authorized system. A commissioned officer will supervise all firing. 7th. Military map making. Each lieutenant on company duty who has not already done so, and each non-commissioned officer and as many selected privates from each company as practicable, will make a satisfactory foot reconnaissance at least 5 miles long, in the vicinity of the post. The instructions laid down in General Orders No. 12, series of 1868, from these headquarters, will be strictly followed, including the contouring. Especial attention will be given to *making the scales correctly;* (1) no attempt being made to change the natural length of step in the field-work; (2) the plot being made in terms of this natural unit; (3) its absolute length being determined carefully by pacing several times over a known distance; and (4) a correct scale being constructed from these data with 100 yards as the unit, the zero being between the first and second divisions on the left, and the first division being subdivided into ten equal parts. The plot will distinctly show the *beginning and end of the reconnaissance*, without any attempt at compromising discrepancies.

The captains will submit to these headquarters, *on or before the determination of the season*, the several maps and drawings, each duly approved by themselves.

SUBMARINE MINING.

A weekly detail of two company officers from different companies will be made, who will spend seven hours daily on this duty (Saturday and Sunday excepted). They will be excused from all other duties except dress parades and inspections, and will be governed by General Orders No. 4, series of 1873, from Battalion headquarters.

The company commanders and Battalion staff officers will occasionally be detailed to relieve Captain Price in the duty of supervising these drills.

A weekly detail will be made of two non-commissioned officers and of twelve privates, from the companies not on the roster for special drills in engineering, for one week. These details will be so arranged as to include, in succession, every man in the Battalion not especially excused by the commanding officer. On certain specified weeks this detail will be constituted entirely of non-commissioned officers, when special attention will be given to covering the entire ground as nearly as possible.

In the absence of commissioned officers, Sergeant William H. Brown, Company A, and Lance-Sergeant Henry Warner, Company B, assistant instructors in submarine mining, will be in general charge of this detail.

During fatigue hours (except on Saturday and Sunday) the men will be instructed (1) in the duties of the boat service, and (2) in those of the loading-room, as prescribed in the proof edition of the Manual.

The following system will be observed as closely as the weather permits. Any omitted drill will be had on Friday if possible.

1st. MONDAY. *Judgment torpedo drill.*—The mapping drill will first be practiced, then the judgment firing drill. A few steamers or sailing vessels should be tracked at every drill, and the diagrams will be neatly finished and preserved.

2d. TUESDAY. *Placing the junction boxes.*—This drill will be simulated on land until the principles are fully understood by every member of the detail. It will then be executed on the river, using the base line between the fort and engineer wharf. Care must be taken, by providing buoy ropes of sufficient length, to avoid the loss of anchors.

3d WEDNESDAY. *Planting a triple group of mines.*—One officer will act as electrician, and the other will command on the steam-launch; the former, on Monday or Tuesday, will set up the apparatus completely in the new operating shed, so that everything shall be in readiness. All the tests used in planting a grand group will be made. Before the end of the week the mines will be raised and all the apparatus returned to the confidential room. If the weather should prevent the completion of this work, the same detail of officers will be made for the following week, due credit being given on the roster.

4th THURSDAY. *Automatic firing drill*—This drill must first be practiced at the wharf, in the manner prescribed in the Manual. Subsequently it may be combined with the judgment drill on the river.

5th. *Daily instruction in rowing.*—This drill (weather permitting) will be under the direction of Lance-Corporal Lane, Company C, assistant instructor in submarine mining, and will be had between morning fatigue call and 8.30 a. m.

6th. In unfavorable weather the detail will be exercised in the duties of the loading-room, in the shore duties pertaining to the boat service, and in the use of the dial telegraph. Verbal instruction will be given respecting the fuzes, explosives, torpedo material—except that of the operating room—simple electrical testing, and the practical use of the ordinary forms of apparatus for the electrical ignition of mines. This may be done in the Torpedo Museum, by reading and elaborating portions of the text of the Manual.

On each Saturday the officer in charge will submit the plots of the mapping drills and a report giving the names of the enlisted men, what they have been drilled in, and their classification as to proficiency; printed blank forms will be supplied. Also personal reports from each officer showing what he has accomplished, with notes of his tests and a statement of any difficulty encountered, and any suggestions he may desire to make.

Before the end of the season the grand group of mines planted in 1881 will be raised and replanted, and trial runs and dock trials with the fish torpedo and experiments with new explosives will be continued under special directions from the lieutenant-colonel commanding.

CIVIL ENGINEERING.

The following instrumental surveys will begin at once, and officers will be excused from all other duty when detailed for this purpose. The detail will be made by the adjutant upon the application of Captain Knight from companies on no special roster in engineering.

Each lieutenant on company duty, who has not already done so, will make and plot a careful instrumental survey of at least 1 square mile of ground near the peninsula of Great Neck, connecting with the former surveys in that vicinity. The work will include contours with a surveyor's level. He will be assisted in the field work by details of non-commissioned officers and privates from his company. The work will be plotted on a scale of 12 inches to the the mile, with contour planes 10 feet apart, and may be executed upon any recognized system preferred by the officer. Good level bench-marks should be made and located on the map, the references being given in a column of notes. The names of the residents should be recorded. A field azimuth of one of the lines will be determined astronomically. Practice with the odometer will be had between Willets Point and camp. The finished maps will be submitted on or before the termination of the drill season.

An extension of the careful hydrographic survey of last season towards the main channel will be made by the lieutenants on company duty serving their second year with the Battalion.

The course in field magnetic observations is for officers serving their second year with the Battalion, and will be carried out as fully as the facilities at hand will permit.

Practice in the use of the Repsold base apparatus will be had by officers serving their second year with the Battalion.

The course in tidal and current measurements will comprise observations with the self-registering tide-gauge, with the electric current-meter, and with double floats. It will be confined to officers serving their second year with the Battalion, and will include a full set of observations and a discussion of the same.

FIELD ASTRONOMY.

All the lieutenants who have not already completed the course and been excused from further observations will constitute the observers, being called upon by Captain Bailey as wanted. In addition, when officer of the day (except on Sundays), the weather permitting, they will observe the sun or stars for time. These observations will be computed at once in the book prepared for the purpose, and the error of the *mean solar* chronometer will be distinctly recorded there and on the guard report, where, in case no observations are taken, the cause should be stated.

The following system will govern the observations at the observatory. The course covers two seasons, the first including sextant work, and transit and zenith telescope work with the instruments in the east wing and on the outer pier; and the second including sextant work, practice with the new combined instruments in the west wing, and with the equatorial. Advantage will be taken of every suitable night for observing. Officers wishing to use the instruments for special observations or practice must apply for authority to do so.

Special note-books will be provided for each officer; which, after the end of the season and inspection by the commanding officer, will become his personal property. Suitable blank books will be printed, both for observations and computations; and these original records will be pasted into the books, thus rendering them valuable for future reference.

The computations will receive special attention (1) as to methods employed; (2) as to the values adopted for the instrumental constants; and (3) as to rejection of doubtful observations. The latter is more than usually important, because knowledge of the correct result is likely to bias the judgment. The following rules will be strictly observed: No correction of the original record is to be made subsequently; if clearly wrong the observation must be rejected. No rejection of an observation is allowed, unless (1) it was marked doubtful at the time; (2) it is thrown out by Peirce's criterion; or (3) its discrepancy is so largely in excess of any probable limit as to render some exceptional cause certain; for instance, a discrepancy of 1 minute in a zenith telescope latitude. Every rejection under this third case must receive the approval of the officer charged with supervising the computations.

The following allowance of time will be made for computations: Three days for a set of latitude observations with the sextant, for a set of time observations with the transit, for a longitude by Jupiter's satellites, for the value of a level division or for a micrometer turn with the zenith telescope; ten days for a longitude by moon culmination, or by lunar distances, or by an occultation by the moon, or for latitude by the zenith telescope. THESE LIMITS AS TO TIME MUST BE STRICTLY OBSERVED, AND DAILY REPORTS WILL BE SUBMITTED IN WRITING TO THE INSTRUCTOR EXPLAINING THE REASON OF ANY DELAY.

The following will be the ordinary routine of observations with the several instruments:

Sextant.—After becoming skillful in the use of this instrument upon the sun, observers will deduce at least one satisfactory latitude by observing a north and a south star, using the time deduced from an east and a west star, each based on ten altitudes taken on the same night. Finally, they will deduce one longitude by the method of lunar distances, *using stars and not the sun*, computed by Chauvenet's method. These observations are not designed for the regular observatory detail, but may be made when officer of the day or at such other times as may be convenient. They must be made near the observatory, and the time results must be reported for the Lukens chronomer. *No other record will be accepted* The results will be reported to Captain Bailey and the work done under his direction.

Transit.—A set of time observations for rating the chronometer will be made about once a week, observing a star above and a star below the pole for deviation, and about five south stars for time. Occasionally an observation on a slow circumpolar star will be made for determining the collimation constant. Every moon culmination occurring before 1 a. m. will be observed, until each officer has secured at least one satisfactory result.

At first time will be recorded by the instructor; then the observer will take his own time; lastly, the field chronograph will be used.

Zenith telescope.—Observers will first determine the level correction by daylight, using a distant terrestrial object, or at night using a slow circumpolar star. They will then find the value of a turn of the micrometer by observing Polaris at elongation. Lastly, they will observe for latitude, until they have obtained a satisfactory determination based on three nights' work upon not less than twenty pairs.

The combined transit and zenith telescopes.—These instruments will be used only by officers serving their second year with the Battalion, the object being to give familiarity with the latest special patterns in use by the Corps of Engineers.

Equatorial telescope.—Every practicable occultation of a star of the sixth or higher magnitude by the dark limb of the moon will be observed; also every eclipse of Jupiter's satellites, either with this instrument or with an astronomical telescope, until each officer serving his second year has obtained one satisfactory result. Suitable lists will be prepared in advance, so that no opportunity may be lost.

Personal equation machine.—Each officer will occasionally take a set of observations (80 to 100 transits) to determine his personal equation. This work will be done on cloudy nights. (See Battalion Order No. 3, series of 1882, for form of record.)

Astronomical azimuth.—Each officer serving his second year will determine an astronomical azimuth accurately, using a large theodolite for the purpose. The results will be reported in a shape for publication.

MILITARY PHOTOGRAPHY.

The officers' laboratory will be open daily from 1.30 p. m. until 4 p. m. The building, apparatus, chemicals, &c., will be under the charge of Lieutenant Lusk, Battalion quartermaster, whose duty it is to furnish any desired assistance, and who will be held responsible for the judicious use of the property.

Officers are invited to avail themselves of the advantages of the laboratory, making such arrangements with the officer in charge as shall insure no confusion in his official duties or in those of the men under his instruction.

The instruction of enlisted men will be restricted to one from each company selected from those having special aptitude. They will be detailed singly for one week in turn, and will receive such instruction as in the judgment of the officer in charge is best suited to perfect their knowledge of the subject.

Detail of enlisted men.—Company A, Ichabod F. Crippen, second-class private; Company B, Charles M. Beer, first-class private; Company C, Robert Sturm, first-class private.

WEST POINT, NEW YORK.

It is desired that, so far as circumstances will permit, the men of Company E, stationed at West Point, may receive instructions similar to that of the rest of the Battalion. The company commander at the end of the season will report fully how far this has been practicable, with any recommendations he may desire to make.

By order of Lieutenant-Colonel Abbot.

HARRY F. HODGES,
First Lieutenant of Engineers, Adjutant.

APPENDIX No. 3.

REPORT OF THE BOARD ON FORTIFICATIONS OR OTHER DEFENSES, APPOINTED BY THE PRESIDENT OF THE UNITED STATES UNDER THE PROVISIONS OF THE ACT OF CONGRESS APPROVED MARCH 3, 1885. WILLIAM. C. ENDICOTT, SECRETARY OF WAR, PRESIDENT.

ORDER OF THE PRESIDENT.

EXECUTIVE MANSION, *Washington*, *May* 12, 1885.

Under a provision of an act of Congress entitled "An act making appropriations for fortifications and other works of defense, and for the armament thereof for the fiscal year ending June thirtieth, eighteen hundred and eighty-six, and for other purposes," approved March 3, 1885, a Board, to consist of the officers and civilians hereinafter named, is appointed to "examine and report at what ports fortifications or other defenses are most urgently required, the character and kind of defenses best adapted for each, with reference to armament," and "the utilization of torpedoes, mines, or other defensive appliances":

Hon. William C. Endicott, Secretary of War, president of the Board.
Brigadier-General Stephen V. Benét, Chief of Ordnance.
Brigadier-General John Newton, Chief of Engineers.
Lieutenant-Colonel Henry L. Abbot, Corps of Engineers.
Captain Charles S. Smith, Ordnance Department.
Commander W. T. Sampson, U. S. Navy.
Commander Caspar F. Goodrich, U. S. Navy.
Mr. Joseph Morgan, jr., of Pennsylvania.
Mr. Erastus Corning, of New York.

GROVER CLEVELAND.

The Board convened by order of the President has the honor to submit the following report:

The reports of the Chief of Engineers of the Army have annually laid before the country the condition of the national defenses, and attention is specially invited to those of 1880, 1881, 1882, and 1884.

Without enlarging upon this subject, it suffices to state that the coast fortifications, which in 1860 were not surpassed by those of any country for efficiency, either for offense or defense, and were entirely competent to resist vessels of war of that period, have, since the introduction of rifled guns of heavy power and of armor plating in the navies of the world, become unable to cope with modern iron or steel clad ships of war; far less to prevent their passage into the ports destined for attack.

Prior to 1860 the largest gun in service was the 10-inch Rodman smooth-bore, the energy of whose projectile was 2,000 foot-tons. The forts of that period were more than competent to resist its projectile;

it should form, therefore, no subject of reproach because at present they cannot withstand the shock of 20,000, 30,000, and 45,000 foot-tons of energy, without mentioning the new guns under construction, expected to deliver 61,000 foot tons of energy. On the other hand, the assumption should not be made that existing fortifications may not be effective at short range against unarmored or light-armored ships. At many sites, also, they are of indispensable value as citadels or keeps to secure the position against attacks by land, and as flanking works for torpedo lines.

Some idea of the wonderful change in guns since 1860 may be obtained from comparing the weights of the projectiles, which, during this period, have increased about twenty fold. This increase in power of guns necessitates the use of large masses of armor in important parts of defensive works and largely increases their cost compared with the old works.

It is of no advantage to conceal the fact that the ports along our seacoast—a length of about 4,000 miles, not including Alaska—invite naval attack; nor that our richest ports, from their greater depth of water and capacity to admit the largest and most formidable armored ships, are of all the most defenseless.

The property at stake exposed to easy capture and destruction would amount to billions of dollars, and the contributions which could be levied by a hostile fleet upon our sea-ports should be reckoned at hundreds of millions.

It is impossible to understand the supineness which has kept this nation quiet—allowing its floating and shore defenses to become obsolete and effete—without making an effort to keep progress with the age, while other nations, besides constructing powerful navies, have not considered themselves secure without large expenditures for fortifications, including armored forts.

Our nearest neighbor, though reasoning from the past, she should have no occasion to dread a naval attack from us, has nevertheless constructed armored forts at Halifax and Bermuda, both as a refuge for her fleets and as outposts for offensive operations.

In the mean time we have acquired great riches and apparently dreamed that prosperity should inspire friendship and not envy in less favored peoples—forgetting that riches are a temptation, and that the plunder of one of our sea-ports might abundantly reimburse an enemy for the expenses of a war conducted against us.

Had another policy prevailed and been consistently pursued towards the formation of a suitable coast defense, we should at the present moment have nothing more serious to engage our attention than a measured development in the strength of the works of defense and in the power of guns, in order to keep pace with the gradual progress in the means of attack.

Unfortunately the immense labor of novel constructions must be undertaken under circumstances where careful workmanship is required and haste would be impossible. Under the most favorable conditions a long period would be required to place the defense upon a secure basis, and who shall guarantee that this can be effected free from complications with foreign powers? The Gun-Foundry Board has estimated that it would require at least three years to establish proper plant for the construction of modern guns. It would in all probability require two years more to get out and prove the first 16-inch gun. That there may be no delay in mounting the guns as fast as completed, the work upon the extensive foundations for the gun emplacements, as well as magazines, shell-rooms, engine-rooms, and other constructions necessary for the service of the guns, should be commenced at the earliest moment.

WHERE DEFENSES ARE MOST URGENT.

The first in the order of the duties imposed upon the Board is to examine and report at what ports fortifications or other defenses are most urgently required.

Preliminary to a decision upon this important matter, it is proper to discuss briefly the objects to be secured by a defense of the coasts, and the nature of the attack to which these are most exposed.

To the last named the answer would be—a naval attack. An attack by land, if attempted in force, must be resisted by the armies of the country, and the mode of doing this it is not necessary here to consider.

The objects against which a naval attack would be directed are—

First, the important commercial ports, containing, in addition to the shipping, large magazines of the products of commerce, and which are, on account of public and private wealth, tempting marks to an enemy. Such cities are also railroad centers, and their capture by an enemy would derange, not only the internal commerce by land, but also interfere with the transportation of troops and *matériel* of war; and this might occur at critical junctures during military operations. And if, in addition, these places should be the sites of navy-yards, naval stations, and of depots of military and naval stores, the loss and injury to the country would be greatly increased.

In the second place, vessels in the foreign trade must be protected—this at sea could be performed only by the navy—but when these arrive upon the coast, they should find fortified harbors of refuge provided for their security.

The third object of attack and capture would be the vessels employed in the coasting trade. A glance at the map of the coast will clearly indicate the dangers to which this commerce is exposed. An enemy having superior naval power might intercept all communication coastwise between New York and the ports of New England, by cruising in Vineyard and Long Island Sounds. His cruisers watching Sandy Hook, the mouths of Delaware and Chesapeake Bays, the coasts of Georgia, and the Carolinas, the Florida straits, and the Gulf coasts, would subject this trade to such risk of capture that during war it would be virtually suspended. Nor could this result be prevented by our Navy, even if provided with more numerous and more suitable vessels than past experience would seem to insure, because of the immense stretch of the coast and of the crowd of fast cruisers and of privateers which could be let loose to capture and destroy. When the country shall have been provided with a few fast cruisers, their employment should be in depredating upon the enemy's property and commerce, instead of engaging in a futile attempt to protect the coasting trade over a line extending for 4,000 miles. Experience has also taught us that a few Confederate privateers sufficed to annihilate or suspend our commerce upon the seas, and we should be ready to apply the lesson so taught to an enemy's commerce.

By the suspension of the coasting trade the lines of interior navigation would become of importance. The meaning must be restricted here to the portions of those lines where a hostile vessel could not easily penetrate, and hence would only include the route from New York to Baltimore by canal and otherwise; that from Norfolk to Beaufort, N. C., and that from Savannah to the Saint John's River, though this last-named line might be penetrated at several points.

The subject of the defense of the coasts has usually been treated upo the supposition of the existence of a navy not equal to the fleets of t enemy, but sufficiently numerous to impose upon him the necessity concentration and the avoidance of large detachments from his forc but this view of the case the Board is not called upon to discuss, for does not exist, and it will, besides, be found in the sequel that some the ports named for defense will be strategic rendezvous for fighti ships of war, when these shall have been built in adequate numbers f operating in force against the enemy.

PORTS ARRANGED IN ORDER OF URGENCY.

1. New York.
2. San Francisco.
3. Boston.
4. The lake ports.
5. Hampton Roads.
6. New Orleans.
7. Philadelphia.
8. Washington.
9. Baltimore.
10. Portland, Me.
11. Rhode Island ports in Narragansett Bay.
12. Key West.
13. Charleston, S. C.
14. Mobile.
15. New London.
16. Savannah.
17. Galveston.
18. Portland, Oreg.
19. Pensacola, Fla.
20. Wilmington, N. C.
21. San Diego, Cal.
22. Portsmouth, N. H.
23. Defenses of Cumberland Sound Fort Clinch.
24. Defenses of ports of the Kenneb River, Maine, at Fort Popham.
25. New Bedford, Mass.
26. Defenses of ports on the Penob River, Maine, at Fort Knox.
27. New Haven, Conn.

The list of ports is not exclusively arranged in the order of comm cial importance, some reference being had to the facility of defendi certain sites, and the greater or less period of time which this ta might demand, Baltimore, Savannah, Wilmington, and others belo to the class where in an emergency obstructions might be improvised t check temporarily a hostile squadron.

It is not possible to arrange the smaller ports always in the order importance, also because the necessity of a fortified harbor of refu may be more urgent upon a long stretch of exposed coast, although t port there situated might be inferior in wealth and importance to othe to which it has been preferred.

The Board, in limiting the list to the names above, does not wish it t be understood that there are no other places along the coast which ar of the importance necessary to justify measures of defense. There ar others, but the works of defense already existing at some of these, and the force of any probable attack which would be directed against them, do not make it necessary to call particular attention at this time to their condition and needs.

The Board, in stating "at what ports fortifications or other defenses are most urgently required," presents the following list:

1. New York.
2. San Francisco.
3. Boston.
4. The lake ports.
5. Hampton Roads.
6. New Orleans.
7. Philadelphia.
8. Washington.
9. Baltimore.
10. Portland, Me.
11. Rhode Island ports in Narragansett Bay.

THE DEFENSES AND THEIR ACCESSORIES.

In the sequel the objects to be gained by the defense of the principal ports, as well as of others named in this report, will be commented upon. The Board will now consider "the character and kind of deenses best adapted for each, with reference to armament" and "the utilization of torpedoes, mines, or other defensive appliances," taking up the subject in the order in which it is presented to it.

The defenses, as to character and kind with reference to armament, should be fixed and floating, one or both, according to locality, armed with powerful cannon needed to repel attack from the most formidable ships.

In the phrase "floating defenses" just used, the armored sea-going ship of the Navy is not referred to. We have none of that kind, and if hereafter built in sufficient number and power they would act offensively and not be confined to the defense of ports. The floating defenses mean floating batteries designed specially for operating in harbors or close to the land—armored more heavily and armed with heavier guns than any probable adversary. Of considerably less draught than the armored sea-going ship, they could, by operating among the shoals, avoid ramming, and even torpedoes. To gain such advantages, speed must be sacrificed, but it is quite evident that for the defense of harbors and bays the advantages of extra thickness of armor and of superior power of gun more than compensate for that loss. These batteries are costly, and their use should be restricted to cases of necessity; as, for instance, where the port is so near to deep water that a bombardment may not otherwise be prevented; also in localities where the nature of the foundations forbids the construction of fixed defenses, or where the width of the channel is too great to be well swept from shore batteries. Besides the floating batteries hereinafter specifically recommended, the Board desires to point out that while not required at present, others may be useful to guard the eastern end of Long Island Sound and the approaches on that side to New York, and in Chesapeake Bay as an outer line of defense to Baltimore, Washington, and Hampton Roads.

The shore batteries may be armored turrets, revolving or fixed, armored casemate, and emplacements in barbette. The materials used in construction for the armor might be either iron or steel, although the latest experiments indicate the superiority of forged steel plates. While the Board is of opinion that forged steel plates should be used, it also recommends that immediate experiments be undertaken to determine the most suitable armor for turrets and casemates. Earthen parapets and traverses, sometimes arranged with a core of concrete or rubble masonry to gain resistance to shot, are generally used for barbette batteries.

It is not generally considered possible to bar the progress of an armored fleet by the mere fire of the battery; some obstruction sufficient to arrest the ships within effective range of the guns is necessary. The kind of obstruction now relied upon is the torpedo in the form of a submarine mine, and except in special cases exploded by electric currents, which are so managed that the operator on shore can either ignite the mine under the ship's bottom or allow the ship to explode it by contact. In deep channels the submarine mines are buoyant; in comparatively shallow waters they are placed upon the bottom; the object in both cases being to touch or nearly approach the hull of the vessel. Submarine mines are not accessories of the defense, but are essential features, whenever they can be supplied. Bomb-proof operating rooms and tunnels for the conveyance into the water of the electric cables are necessary parts of the system, and must be constructed in advance of the occasion for their use.

Special batteries of guns are instituted for the defense of the lines of mines against the attempt of unarmored or light-armored boats to countermine or grapple for their attachments. These guns may be arranged with electrical connections so as to be discharged by the very attempt to meddle with the system. The smooth bores of 8 and 10 inch calibers and the 8-inch converted rifles already in service will be needed to defend the mines against attempts of this nature; but it would be advisable to replace them in part with 5, 6, and 8 inch rifles. The guns thus displaced, together with the 15-inch smooth bores now on hand, will be usefully employed in the defense of places of minor importance.

When practicable every mine-field should be commanded by electric search-lights, so that the enemy's attempts at night to tamper with the mines may be detected and rendered abortive.

Movable torpedoes operated from shore stations are still in the experimental stage; and no definite recommendation except for experimental trials could now be made. The successful operation of these torpedoes would add another element to the defense of the mines.

Torpedo boats would prove of great use in defeating attempts against the mines, made either with small or large vessels.

Heavy batteries and submarine mines are correlative terms of a good defense from the shore. Without powerful guns in the defense the armored ships of the enemy would proceed deliberately to the removal of the mines, either ignoring or silencing the fire of the works, and without the aid of the mines the enemy's vessels could not generally be prevented from running past the batteries.

To serve the mines, operating casemates, cable-tunnels, and electric search-lights are necessary. An instructed *personnel* is required for the placing into position and the service of submarine mines, owing to the technical nature of the operations. The Battalion of Engineers instructed in this duty is now restricted to 400 men. So soon as proper accommodations can be arranged for them at the post of Willets Point, the number should be increased to the limit allowed by law.

Rapid firing guns also would be of use against the torpedo boats and the unarmored portions of ships, and a certain number should be provided in the defense. Machine guns for flanking defenses and sweeping mine-fields, for repelling assaults upon the works, and for other purposes, will be necessary.

The material of which the powerful guns needed in the fixed and floating defenses are to be constructed is also a proper subject of discussion if it is intended to secure strength with a minimum of weight, which the Board deems of much moment, in view of the complication, weight, and additional cost of the gun-carriages arising from the increased dimensions of the gun, and of other vital considerations.

Cast iron as material has been advocated on account of supposed cheapness and facility of manufacture, but the sole method of arriving at a sound conclusion in this respect is a careful analysis. A comparison has been made between breech-loading cast-iron rifles and Krupp's steel rifles, which by no means sustains the claims either of superior economy or facility of manufacture for a cast-iron gun of power equal to one made of steel.* On the other hand the difference of weight

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*The following comparison of the weight and power of cast iron and steel guns is based upon the actual performance of the United States experimental 12-inch breech-loading rifle, cast iron, and the Krupp 12-inch breech-loading rifle, steel, the brown German prismatic powder being used with both guns.

Results somewhat more favorable, it is true, have been obtained with the 12-inch breech-loading rifle, cast iron, from the use of Dupont's brown prismatic powder, than given below; but it is fair to assume that results equally favorable would attend the employment of Dupont's powder with the Krupp 12-inch rifle; consequently the regainst the cast iron appears to be 66 per cent. of the weight of the teel gun, a defect which would greatly interfere with facility of maneuver and rapidity of fire. It would be singular if, after waiting for so many years with the alleged intention of profiting by the experience of nations foremost in the manufacture of heavy ordnance, we should begin the long-neglected defense of the country with accepting a material for guns which, after having been tried by leading European nations, has been deliberately rejected in favor of steel. The Board emphatically recommends steel.

The great improvement in the quality of steel and in the manufacture of slow-burning powders, with the resulting increase in the length of bore and weight of the charge, has already within a few years past led to a marked increase in the velocity and energy of the projectile, with-

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sults obtained with the German powder, which has been actually tested with both guns, will furnish quite as good a basis for comparison.

By virtue of certain well-established principles in gunnery, relative to the similitude of guns, with similarity of loading, it is easy to deduce the caliber and weight of a piece, of either of the above types, which shall possess a given power, or which shall have the *same* power, for instance, as a piece of the other type. In this way we may reduce our data to the same absolute standard, and thus give our analysis a strictly quantitive character.

Data.	Powder.	Charge.	Projectile.	Velocity.	Pressure.	Energy at muzzle.
		Lbs.	*Lbs.*	*Feet.*	*Tons.*	*Ft-tons.*
United States 12-inch B. L. rifle, cast iron; weight, 54 tons; length of bore, 28 calibers..	German brown.	265	800	1,709	14.0	16,197
Krupp's 12-inch B. L. rifle, steel; weight, 48 tons; length of bore, 32 calibers............	......do........	357	1,003	1,857	17.3	23,907

From the above it appears that the Krupp 12-inch rifle imparts to its projectile 7,710 foot-tons more energy than the 12-inch cast-iron rifle; and it is this energy (smashing effect) which is assumed to be the measure of effect against hard armor, as steel, with which all new types of armored ships are now plated, and is therefore the material against which guns for coast defense will in future be required to contend.

The price of the experimental 12-inch rifle, cast iron, was about $540 per ton; that of the Krupp 12-inch rifle was probably not more than $1,120 per ton, making the total cost of the first $29,160, and of the other about $53,760. The relative weight of piece to energy of projectile is, for the 12-inch cast-iron gun, 33 tons, and for the Krupp 12-inch gun 20.1 tons, or less than two-thirds that of the cast-iron gun. The energy per pound of powder is 61 foot-tons for the 12-inch cast-iron gun, and 67.2 foot-tons for the Krupp 12-inch gun.

Let us now compare these results by a common standard. Under the limitations imposed in connection with the principle of the similitude of guns, &c., we assume that the weight of the piece, of the charge, of the projectile, and the energy of the projectile are directly proportional to the cube of the caliber.

(1) What will be the caliber, weight of piece, of charge, and of projectile of a cast-iron gun that shall possess the same energy as the Krupp 12-inch rifle, viz, 23,907 foot-tons.

From our premises, given and assumed, we deduce the following, viz:

Caliber.	Length of bore.	Weight of piece.	Charge.	Projectile.	Velocity.	Pressure.
Inches.	*Calibers.*	*Tons.*	*Pounds.*	*Pounds.*	*Feet.*	*Tons.*
13.7	28	79.7	391	1,180	1,709	14

As has been stated, the price of the 12-inch cast-iron gun was about $540 per ton, which would give as the cost of this 80-ton gun $43,092. But in the manufacture of a second gun similar to the 12-inch cast-iron rifle, three separate castings proved failures. The failure of the first ought to have been foreseen and could have been preout impressing an undue strain upon the walls of the gun, and it is this condition of the art which has set aside that which at one time promised to be a useful invention—guns manufactured on the multicharge principle, such as the "Haskell" and "Ripley." The Board cannot recommend the manufacture or purchase of either of these guns. From information which appears to have been carefully compiled and laid before the Board the Haskell multicharge gun would much exceed in weight and cost a single-charge gun of the same power.

The nature of the projectile to be used will vary with the target. Common shell of steel or iron carrying large bursting charges will be effective against the unarmored parts of vessels. Against wrought iron plates the projectile may be made of chilled cast iron; but hard armor extacts for its penetration or destruction the use of steel, forged and

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vented. The failure of the second occurred by successive transverse fractures while in the lathe, and the third was ruptured longitudinally while still in the casting-pit. These failures, even now, are not clearly understood, and their tendency is to largely increase the uncertainty and risk attendant upon the manufacture of these large castings, and thus to enhance their cost. It is highly probable, therefore, that the cost per ton will materially increase for a cast-iron gun of 80 tons weight, and it may not be far out of the way, perhaps, to assume the cost for such a gun at $600 per ton, or, say, a total cost of about $48,000. To this sum must be added the increased cost for the very much larger and heavier carriage required for the service of such a piece, which will, it is quite safe to say, bring up the aggregate cost fully to that paid for the Krupp 12-inch rifle, with its mounting.

But it is important to bear in mind that, as yet, we have no evidence touching the endurance of cast-iron guns, the experimental 12-inch cast-iron gun having been fired, up to the present date, only about thirty rounds. And, further, we have no guarantee whatever that a satisfactory endurance with one cast-iron gun will prove a safe criterion in respect to the endurance of the next one that may be tried, so many and so great are the uncertainties attendant upon the production of sound, strong castings of such large mass.

Let us now solve the inverse problem, viz:

(2) What will be the caliber, weight of piece, of charge, and projectile of a *steel* gun of the Krupp type that shall have the same energy as the 12-inch cast-iron gun, viz, 16,197 foot-tons?

In this case we deduce the following:

Caliber.	Length of bore.	Weight of piece.	Charge.	Projectile.	Velocity.	Pressure.
Inches.	*Calibers.*	*Tons.*	*Pounds.*	*Pounds.*	*Feet.*	*Tons.*
10.5	32	32½	242	677	1,857	17.3

At $1,120 per ton, this gun would cost $36,400. But the cost of Krupp's 12-inch rifle of 37 tons, as given on a price list of 1882, was only $1,012 per ton, so that we may assume from $32,500 to $36,400 as the cost of the 10½-inch gun of 32½ tons weight.

These figures, as compared with the price—$29,160—paid for the 12-inch cast-iron gun, are quite favorable to the steel gun; the difference in cost is not great, particularly when it is remembered that *cheapness* is the chief merit claimed for cast iron, as an offset to its manifold imperfections.

It will be observed that the same energy is here obtained with a gun of about one-half the weight of the cast-iron gun, and which therefore possesses great advantage with respect to facility of handling, and permits besides of a considerable saving in weight of charge and projectile.

Referring again to the failure of the three 12-inch gun castings, the limit of weight for cast-iron guns would seem to be practically reached with a 12-inch rifle of 54 tons weight; and their production in quantity, even of that caliber and weight, will unquestionably seriously delay the development of the steel industry of this country, to which alone we must have recourse for guns of the highest power, and indeed for guns of all calibers and of whatever power, where strength, lightness, and facility of handling are *desiderata*.

In conclusion, it may be stated that the prices paid for Armstrong's steel guns, so far as they have been made public, are less than the figures assumed above as the cost of guns of Krupp manufacture.

tempered. In connection with steel armor piercing projectiles, reference may be made to a system of manufacture by which steel shot are rolled of superior quality and true to gauge. So far the process has been applied only to small calibers, but if successful for larger ones a needed supply will be obtained at a small cost.

Among the most important means of conducting an active defense of the coast is the torpedo boat, which, although recently developed, has received the sanction of the nations of Europe, each one of which now possesses a large number of these vessels. Their use will be quite general, first, in disturbing blockades and preventing these from being made close, as no fleet would like to lie *over night* within striking distance of a station of these boats; second, in attacking an enemy's ship enveloped in fog or smoke; third, in relieving a vessel pursued by the enemy; fourth, in defending the mines by night and day against attempts at countermining, and in many other ways not necessary to recapitulate.

Impressed with the utility of this mode of defense, the Board has recommended the construction of 150 of these boats, and desires further to say that in its opinion this service requires a special corps of officers and men from the Navy trained to their use.

The self-moving torpedo, one example being the "Whitehead," would be the main reliance. The star torpedo might be used from launches, but as in general this service would be of the nature of a forlorn hope, and liable to fail of success, its principal recommendation would be ease of improvising and the absence of other suitable means to the end.

Submarine boats have not passed the experimental stage, and the Board has at present no recommendation to make in their regard.

Aerial torpedoes with large charges of high explosives projected in curved or vertical fire, while they demand consideration, have not yet arrived at a stage of development demanding practical discussion.

LIST OF PORTS, WITH DESCRIPTION OF FORTIFICATIONS AND OTHER DEFENSES WITH REFERENCE TO ARMAMENT, MINES, TORPEDOES, ETC.

(1) *New York.*—This important port must be fortified at both entrances in the most thorough manner. *Fortifications:* Turrets, armored casemates, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Eighteen torpedo-boats are recommended for service in this harbor.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
16-inch	110-ton guns	18	B. L. R.
14-inch	80-ton guns	2	B. L. R.
12-inch	50-ton guns	40	B. L. R.
10-inch	27-ton guns	20	B. L. R.
8-inch	13-ton guns	15	B. L. R.
12-inch	Mortars	144	Rifles.

(2) *San Francisco.*—This is a most exposed point, and, owing to the width across the channel, difficult to be defended by guns from the shore. Floating batteries are consequently required to be added to the defense. *Fortifications:* Turrets, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Eighteen torpedo-

boats are recommended for service at this harbor. Three floating batteries are recommended for the defense in addition to the land batteries.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
16-inch	110-ton guns	10	B. L. R.
14-inch	80-ton guns	4	B. L. R.
12-inch	50-ton guns	20	B. L. R.
10-inch	27-ton guns	71	B. L. R.
8-inch	13-ton guns	5	B. L. R.
12-inch	Mortars	128	Rifled.

(3) *Boston.*—This port has a wide opening to seaward, with three approaches, and consequently requires extensive works of defense. *Fortifications:* Turrets, armored casemates, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Eighteen torpedo-boats are recommended for service here.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
16-inch	110-ton guns	8	B. L. R.
12-inch	50-ton guns	10	B. L. R.
10-inch	27-ton guns	15	B. L. R.
8-inch	13-ton guns	10	B. L. R.
12-inch	Mortars	132	Rifled.

(4) *The Lake ports.*—The situation being peculiar, an explanation becomes necessary. The treaty of 1817 between the United States and England limited each party to an insignificant naval force upon the Lakes.* At that time the country on both sides was undeveloped; with the exception of Detroit there was nothing perhaps deserving the name of town upon the Upper Lakes. Everything has changed; large cities as centers of commerce now dot the coasts of the lake, and the wealth and property liable to capture and destruction are enormous in amount. In the meanwhile our neighbors over the line have surmounted the rapids of the Saint Lawrence and the Falls of Niagara by canals

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**Arrangement between the United States and Great Britain, made by Richard Rush, esq., acting as Secretary of the Department of State, and Charles Bagot, His Britannic Majesty's envoy extraordinary, &c., concluded April* 28, 1817.

The naval force to be maintained upon the American lakes by His Majesty and the Government of the United States shall henceforth be confined to the following vessels on each side, that is:

On Lake Ontario, to one vessel, not exceeding 100 tons burden, and armed with one 18-pound cannon.

On the Upper Lakes, to two vessels, not exceeding like burden each, and armed with like force.

On the waters of Lake Champlain, to one vessel, not exceeding like burden, and armed with like force.

All other armed vessels on these lakes shall be forthwith dismantled, and no other vessels of war shall be then built or armed.

If either party should hereafter be desirous of annulling this stipulation, and should give notice to that effect to the other party, it shall cease to be binding after the expiration of six months from the date of such notice.

The naval force so to be limited shall be restricted to such services as will in no respect interfere with the proper duties of the armed vessels of the other party.

which, in their present condition, permit the passage of boats of 9 feet draught, and when the improvements shall have been finished will have a depth of 14 feet. The present draught will admit many gunboats now in the possession of Great Britain, and when the depth of water is increased armored vessels from the other side of the Atlantic may float in the waters of Lake Erie. A state of war, therefore, with that power would at this time, unless something be done to avert the consequences, involve the lake cities in frightful losses or even destruction. These cities, being upon the shore, could not by land forts be protected from bombardment. Fort Wayne, on the Detroit River, if supplied with suitable armament well placed, could, with the assistance of submarine mines and torpedoes, prohibit a passage into Lake Huron. The canal at the Sault Ste. Marie would also demand a fort to protect it from destruction.

Our commerce on the Upper Lakes is much more extensive than that of Canada, and doubtless many of the steamers might at a pinch be converted into light-armed naval vessels. But to do this, with any prospect of anticipating the arrival of British gunboats after the declaration of war, the vessels should be inspected, beginning now, and the inspections continued, so that a perfect knowledge might be obtained of the number and description of all that might be fit for the service designed, and plans of their modification to receive the guns be made and kept, so that when the vessels are wanted there should be no unnecessary delay in preparing them for service. It is needless to state that the guns and other necessary material should also be provided, ready for use at a moment's warning.

Upon Lake Ontario the Canadian commerce is superior to ours. Some protection, however, would be needed here, which, imperfect as it is, might serve a good purpose. It is proposed to keep in one of the interior lakes of New York vessels armed with light guns and furnished with self-moving torpedoes, to be sent when needed, by canal, into Lake Ontario. Some might be sent to Buffalo for service in the Upper Lakes. A port of refuge against the superior naval force of England should be provided in the lower part of Lake Ontario.

The fort at Rouse's Point is sufficient, with the addition of a few 8-inch rifles, to secure Lake Champlain from an inroad.

It may be observed that one or more fortifications on the Saint Lawrence River would be required, which, in the event of hostilities, could at once protect our frontier and command the water approaches to the Lakes. They would be more reliable than an improvised fleet upon Lake Erie, though they could not wholly take its place.

Proposed armament.

Locality.	Caliber.	Kind.	Number.	Remarks.
Fort Wayne	10-inch	27-ton guns	3	B. L. R.
	8-inch	13-ton guns	3	B. L. R.
	6-inch	5-ton guns	4	B. L. R.
	10-inch	Mortars	8	Rifled.
Proposed fort on Saint Lawrence River	12-inch	50-ton guns	2	B. L. R.
	10-inch	27-ton guns	6	B. L. R.
	10-inch	Mortars	8	Rifled.
Fort Montgomery, Rouse's Point	8-inch	13-ton guns	4	B. L. R.
	10-inch	Mortars	8	Rifled.

(5) *Hampton Roads.—Fortifications:* Turrets, armored casements, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Eighteen torpedo-boats are recommended for the service here and in Chesapeake Bay.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
16-inch	110-ton guns	4	B. L. R.
12-inch	50-ton guns	10	B. L. R.
10-inch	27-ton guns	20	B. L. R.
12-inch	Mortars	16	Rifled.

(6) *New Orleans.*—It being impossible to place submarine mines in the trunk of the river below the city, but only in the Passes, and as no land batteries could be built there on account of the want of a foundation, it is recommended that the defense of the Passes be confided to two floating batteries, submarine mines, and other torpedoes. Twelve torpedo-boats are recommended for this station.

Proposed armament for land batteries above the Head of the Passes.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	20	B. L. R.
8-inch	13-ton guns	10	B. L. R.

(7) *Philadelphia.—Fortifications:* Armored casemates, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Six torpedo-boats are recommended for service at this place.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	10	B. L. R.
10-inch	27-ton guns	5	B. L. R.
8-inch	13-ton guns	5	B. L. R.
12-inch	Mortars	16	Rifled.

(8) *Washington.—Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	7	B. L. R.
10-inch	27-ton guns	6	B. L. R.

(9) *Baltimore.—Fortifications:* Armored casemates, barbette batteries, mortar batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
2-inch	50-ton guns	5	B. L. R.
0-inch	27-ton guns	5	B. L. R.
8-inch	13-ton guns	5	B. L. R.
2-inch	Mortars	16	Rifled.

(10) *Portland, Me.—Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Six torpedo-boats are recommended for service here.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
2-inch	50-ton guns	20	B. L. R.
0-inch	27-ton guns	10	B. L. R.
8-inch	13-ton guns	10	B. L. R.
12-inch	Mortars	48	Rifled.

(11) *Rhode Island ports.*—Entrance to Narragansett Bay. *Fortifications:* Turret, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Six torpedo-boats are recommended for service in this bay.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
16-inch	110-ton guns	2	B. L. R.
12-inch	50-ton guns	10	B. L. R.
10-inch	27-ton guns	10	B. L. R.
12-inch	Mortars	48	Rifled.

(12) *Key West.*—This port is in the direct route of the Gulf commerce. *Fortifications:* Turret, barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Six torpedo-boats are recommended for service.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
16-inch	110-ton guns	2	B. L. R.
12-inch	50-ton guns	12	B. L. R.
12-inch	Mortars	32	Rifled.

(13) *Charleston, S. C.*—It is necessary to provide fortified ports of refuge along the extended coast line of North and South Carolina and Georgia. *Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Six torpedo-boats are recommended for service along the coast.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	8	B. L. R.
10-inch	27-ton guns	4	B. L. R.
12-inch	Mortars	16	Rifled.

(14) *Mobile.*—A place of commercial importance and the outlet of th products of Alabama. *Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	12	B. L. R.
8-inch	13-ton guns	10	B. L. R.
12-inch	Mortars	16	Rifled.

(15) *New London.*—*Fortifications:* Barbette batteries. Submarin mines will form a part of the defense. Eighteen torpedo-boats are recommended for service.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	4	B. L. R.
10-inch	27-ton guns	4	B. L. R.

(16) *Savannah.*—*Fortifications:* Armored casemates, barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	3	B. L. R.
10-inch	27-ton guns	6	B. L. R.
8-inch	13-ton guns	4	B. L. R.
12-inch	Mortars	16	Rifled.

(17) *Galveston.*—This place cannot be defended by landworks against an active bombardment, and fortifications are proposed simply to prevent an enemy's vessel from entering the harbor. *Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense. One of the light-draught monitors would be useful to assist in the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
8-inch	13-ton guns	8	B. L. R.
12-inch	Mortars	16	Rifled.

(18) *Portland, Oreg.*, at mouth of the Columbia River and above.—*Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense. Eighteen torpedo-boats are recommended for service along the Northern Pacific coast.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
10-inch	27-ton guns	12	B. L. R.
8-inch	13-ton guns	7	B. L. R.
12-inch	Mortars	32	Rifled.

(19) *Pensacola.—Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	2	B. L. R.
10-inch	27-ton guns	4	B. L. R.

(20) *Wilmington, N. C., and mouth of Cape Fear River.—Fortifications:* Armored casemates, barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	4	B. L. R.
10-inch	27-ton guns	5	B. L. R.

(21) *San Diego, Cal.—Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
10-inch	27-ton guns	4	B. L. R.

(22) *Portsmouth, N. H.—Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	4	B. L. R.
10-inch	27 ton guns	4	B. L. R.

(23) *Defenses of Cumberland Sound at Fort Clinch.*—This is the most southern harbor of importance on the Atlantic coast. *Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
12-inch	50-ton guns	2	B. L. R.
10-inch	27-ton guns	2	B. L. R.

(24) *Defenses of ports on the Kennebec River, Maine, at Fort Popham.—Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
10-inch	27-ton guns	3	B. L. R.

(25) *New Bedford, Mass.—Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
8-inch	13-ton guns	3	B. L. R.
12-inch	Mortars	16	Rifled.

(26) *Defenses of ports on the Penobscot River, Maine, at Fort Knox.—Fortifications:* Barbette batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
10-inch	27-ton guns	3	B. L. R.

(27) *New Haven, Conn.—Fortifications:* Barbette batteries, mortar batteries. Submarine mines will form a part of the defense.

Proposed armament.

Caliber.	Kind.	Number.	Remarks.
8-inch	13-ton guns	3	B. L. R.
12-inch	Mortars	8	Rifled.

GUNS ON HAND.

The sea-coast guns now available for use are:

Kind of gun.	Number.	Description.
Rodman guns, smooth-bore	2	20-inch.
Do	308	15-inch.
Do	998	10-inch.
Do	210	8-inch.
Parrott guns, rifled	38	[*]300-pounders.
Do	81	[*]200-pounders.
Do	173	[*]100-pounders.
Converted rifles	[†]210	8-inch.

[*] Of doubtful strength.

[†] 160 on hand, and 50 to be delivered under contract.

Some of these smooth-bore and rifled guns will be used to defend the torpedo lines, and the remainder may be distributed to existing forts and batteries, as well as to ports not named in the foregoing reports. It is probable that with the addition of two modern rifles of minor calibers at such places, with little additional expense for constructions, the existing defenses will suffice to secure ports of minor importance from marauding attacks. For these reasons the smooth-bore guns enumerated above should not be sold. The provisions of the law did not require the Board to make a report including all places where defenses might at some future time be required, and the Board has therefore confined itself to a general mention of this part of the coast defense.

It is not necessary or expected that the order of urgency should be strictly followed in the lower part of the list of ports prepared by the Board, for it is likely that, pending the period at which these ports will be reached in their order, changes impossible to foresee may occur in their relative importance and urgency, and such changes may also modify the extent of the defenses and armament proposed in particular cases, so that what may be taken from one may be added to another.

Attention is invited to the following tabular statements based upon careful study of the local requirements of each port. It has not been deemed expedient, for prudential and other reasons, to make public the actual sites of the batteries:

(1) Estimate for land defenses, exclusive of armament.
(2) Estimate for armament and mountings.
(3) Estimate for floating batteries, including armament.
(4) Estimate for submarine mines and their adjuncts.
(5) Estimate for torpedo-boats.

Estimate for land defenses, exclusive of armament.

[NOTE.—The following estimates are based upon the use of rolled iron for armor plates, because the penetrations into that material have been the most studied, but in view of the substitution of steel, in whole or part, for rolled iron the cost for equivalent protection would probably be the same.]

Number of guns and mortars wanted at different localities.	Iron, wrought and cast.				Cost of masonry and earth.	Total cost.
	Armor, wrought.		Structural metal.			
	Tons.	Cost.	Tons.	Cost.		
New York City, including both entrances:						
9 2-gun turrets	13,635	$4,050,000	2,925	$450,000	$1,800,000	$6,300,000
30 in casemates	13,050	3,900,000	1,950	390,000	1,200,000	5,490,000
8 on lifts				160,000	640,000	800,000
39 disappearing and non-disappearing					1,560,000	1,560,000
144 mortars					288,000	288,000
Total	26,685	7,950,000	4,875	1,000,000	5,488,000	14,438,000
San Francisco:						
5 2-gun turrets	7,575	2,250,000	1,625	250,000	1,800,000	3,500,000
10 on lifts				200,000	800,000	1,000,000
90 disappearing and non-disappearing					3,600,000	3,600,000
128 mortars					256,000	256,000
Total	7,575	2,250,000	1,625	450,000	5,656,000	8,356,000
Boston:						
4 2-gun turrets	6,060	1,800,000	1,300	200,000	800,000	2,800,000
10 in casemates	4,350	1,300,000	650	130,000	400,000	1,830,000
15 disappearing and non-disappearing					600,000	600,000
10 barbette					150,000	150,000
132 mortars					264,000	264,000
Total	10,410	3,100,000	1,950	330,000	2,214,000	5,644,000

Estimate for land defenses, exclusive of armament—Continued.

Number of guns and mortars wanted at different localities.	Iron, wrought and cast. Armor, wrought. Tons.	Iron, wrought and cast. Armor, wrought. Cost.	Iron, wrought and cast. Structural metal. Tons.	Iron, wrought and cast. Structural metal. Cost.	Cost of masonry and earth.	Total cost.
The lake ports, including Fort Wayne and Saint Lawrence River:						
5 in casemates	2, 175	$650, 000	325	$65, 000	$200, 000	$915, 000
8 on lifts				60, 000	240, 000	300, 000
14 disappearing and non-disappearing					560, 000	560, 000
24 mortars					48, 000	48, 000
Land defenses					600, 000	600, 000
Total	2, 175	650, 000	325	125, 000	1, 648, 000	2, 423, 000
Hampton Roads, Va.:						
2 2-gun turrets	3, 030	900, 000	650	100, 000	400, 000	1, 400, 000
10 in casemates	4, 350	1, 300, 000	650	130, 000	400, 000	1, 830, 000
20 disappearing and non-disappearing					800, 000	800, 000
16 mortars					32, 000	32, 000
Total	7, 380	2, 200, 000	1, 300	230, 000	1, 632, 000	4, 062, 000
New Orleans:						
30 disappearing and non-disappearing					1, 200, 000	1, 200, 00
Philadelphia:						
10 in casemates	4, 350	1, 300, 000	650	130, 000	400, 000	1, 830, 000
10 disappearing and non-disappearing					400, 000	400, 000
16 mortars					32, 000	32, 000
Total	4, 350	1, 300, 000	650	130, 000	832, 000	2, 262, 000
Washington:						
18 disappearing					520, 000	520, 000
Baltimore:						
5 in casemates	2, 175	650, 000	325	65, 000	200, 000	915, 000
10 disappearing and non-disappearing					400, 000	400 000
16 mortars					32, 000	32, 000
Total	2, 175	650, 000	325	65, 000	632, 000	1, 347, 000
Portland, Me:						
10 on lifts				200, 000	800, 000	1, 000, 000
30 disappearing and non-disappearing					1, 200, 000	1, 200, 000
48 mortar s					96, 000	96, 000
Total				200, 000	2, 096, 000	2, 296, 000
Narragansett Bay, both entrances:						
1 2-gun turret	1, 515	450, 000	325	50, 000	200, 000	700, 000
5 on lifts				100, 000	400, 000	500, 000
15 disappearing and non-disappearing					600, 000	600, 000
48 mortars					96, 000	96, 000
Total	1, 515	450, 000	325	150, 000	1, 296, 000	1, 896, 000
Total of above 11 ports	62, 265	18, 550, 000	11, 375	2, 680, 000	23, 214, 000	44, 444, 000
Key West, Fla:						
1 2-gun turret	1, 515	457, 000	325	50, 000	200, 000	700, 000
5 on lifts				100, 000	400, 000	500, 000
5 disappearing and non-disappearing					200, 000	200, 000
32 mortars					64, 000	64, 000
Repairs					200, 000	200, 000
Total	1, 515	450, 000	325	150, 000	1, 664, 000	1, 664, 000
Charleston, S. C.:						
4 on lifts				80, 000	320, 000	400, 000
8 disappearing and non-disappearing					320, 000	320, 000
16 mortars					32, 000	32, 000
Repairs					200, 000	200, 000
Total				80, 000	872, 000	952, 000

Estimate for land defenses, exclusive of armament—Continued.

ber of guns and mortars wanted at different localities.	Iron, wrought and cast.				Cost of masonry and earth.	Total cost.
	Armor, wrought.		Structural metal.			
	Tons.	Cost.	Tons.	Cost.		
le, Ala.:						
4 on lifts				$80, 000	$320, 000	$400, 000
disappearing and non-disappearing					720, 000	720, 000
mortars					32, 000	32, 000
epairs					300, 000	300, 000
Total				80, 000	1, 372, 000	1, 453, 000
London, Conn.:						
4 on lifts				80, 000	320, 000	400, 000
4 disappearing and non-disappearing					160, 000	160, 000
epairs					100, 000	100, 000
Total				80, 000	580, 000	660, 000
nah, Ga.:						
5 in casemates	2, 175	$650, 000	325	65, 000	200, 000	915, 000
8 disappearing and non-disappearing					320, 000	320, 000
16 mortars					32, 000	32, 000
Repairs					100, 000	100, 000
Total	2, 175	650, 000	325	65, 000	652, 000	1, 367, 000
ston, Tex.:						
8 disappearing and non-disappearing					$320, 000	$320, 000
16 mortars					32, 000	32, 000
Keeps					200, 000	200, 000
Total					552, 000	552, 000
land, Oreg.:						
12 disappearing and non-disappearing					480, 000	480, 000
barbette					105, 000	105, 000
32 mortars					64, 000	64, 000
Keeps					200, 000	200, 000
Total					849, 000	849, 000
cola, Fla.:						
on lifts				$40, 000	160, 000	200, 000
4 disappearing and non-disappearing					160, 000	160, 000
Repairs					200, 000	200, 000
Total				40, 000	520, 000	560, 000
ington, N. C.:						
5 in casemates	2, 175	$650, 000	325	65, 000	200, 000	915, 000
on lifts				40, 000	160, 000	200, 000
2 disappearing and non-disappearing					80, 000	80, 000
Keeps					200, 000	200, 000
Total	2, 175	650, 000	325	105, 000	640, 000	1, 395, 000
Diego, Cal.:						
4 disappearing and non-disappearing					160, 000	160, 000
Keeps					100, 000	100, 000
Total					260, 000	260, 000
mouth, N. H.:						
8 disappearing and non-disappearing					320, 000	320, 000
Keeps					100, 000	100, 000
Total					420, 000	420, 000
of Cumberland Sound, at Fort ch:						
2 on lifts				40, 000	160, 000	200, 000
2 disappearing and non-disappearing					80, 000	80, 000
Total				40, 000	240, 000	280, 000
nses of ports on the Kennebec River, a., at Fort Popham:						
3 disappearing and non-disappearing					120, 000	120, 000

Estimate for land defenses, exclusive of armament—Continued.

Number of guns and mortars wanted at different localities.	Iron, wrought and cast.				Cost of masonry and earth.	Total cost.
	Armor, wrought.		Structural metal.			
	Tons.	Cost.	Tons.	Cost.		
New Bedford, Mass.:						
8 disappearing and non-disappearing					$120,000	$120,
16 mortars					32,000	32,
Total					152,000	152,
Defenses of ports on the Penobscot River, Me., at Fort Knox:						
3 disappearing and non-disappearing					120,000	120,
New Haven, Conn.:						
3 disappearing and non-disappearing					120,000	120,
8 mortars					16,000	16,
Keeps					100,000	100,
Total					236,000	236,
Grand total	68,130	$20,300,000	12,350	$3,320,000	31,863,000	55,4

Estimate for armament and mountings.

Locality.	Guns.						Mortars.		Cost of guns and mortars.	Cost of carriages.	Total cost.
	16-inch.	14-inch.	12-inch.	10-inch.	8-inch.	6-inch.	12-inch.	10-inch.			
New York City;											
Willets Point	6		10	5	5		48		$1,744,000	$580,000	$2,
Narrows, Sandy Hook, Coney Island	12	2	30	15	10		96		4,263,000	1,412,000	5,6
San Francisco	10	4	20	71	5		128		5,426,000	1,787,000	7,2
Boston	8		10	15	10		132		2,971,000	970,000	3,9
Lake ports:											
Fort Wayne				3	3	4		8	188,600	59,800	24
Saint Lawrence River			2	6				8	310,000	100,000	41
Fort Montgomery, Rouse's Point					4			8	100,000	30,000	13
Hampton Roads	4		10	20			16		1,608,000	534,000	1,14
New Orleans (Mississippi River)			20		10				1,130.000	380,000	1,51
Philadelphia			10	5	5		16		828,000	274,000	1,10
Washington (Potomac River)			7	6					512,000	171,000	68
Baltimore			5	5	5		16		578,000	190,000	76
Portland, Me			20	10	10		48		1,784,000	587,000	2,371,
Rhode Island ports (Narragansett Bay)	2		10	10			48		1,374,000	450,000	1,8
Key West	2		10				82		976,000	320,000	1,2
Charleston, S. C			8	4			16		636,000	210,000	84
Mobile			12		10		16		858,000	284,000	1,142,
New London			4	4					308,000	103,000	411,
Savannah			8	6	4		16		492,000	162,000	654,
Galveston					8		16		232,000	75,000	307,
Portland, Oreg. (mouth Columbia River)				12	7		32		671,000	219,000	89
Pensacola			2	4					208,000	71,000	27
Wilmington, N. C			4	5					335,000	112,000	447,
San Diego, Cal				4					100,000	36,000	136,
Portsmouth, N. H			4	4					308,000	103,000	411,
Defenses of Cumberland Sound at Fort Clinch			2	2					154,000	52,000	206,
Defenses of ports on the Kennebec River, Maine, at Fort Popham				3					81,000	27,000	108,
New Bedford, Mass					3		16		167,000	53,000	220,
Defenses of ports on the Penobscot River, Maine, at Fort Knox				3					81,000	27,000	108,
New Haven, Conn					3		8		103,000	33,000	136,
Total	44	6	203	222	102	4	700	24	28,554,000	9,411,800	37,9

Estimate for floating batteries, including armament.

Locality.	Number of batteries.	Number of guns each.			Total number of guns.			Cost of ships and armament.
		16-inch.	14-inch.	10-inch.	16-inch.	14-inch.	10-inch.	
New Orleans	2	2	....	1	4	....	2	$8, 150, 000 00
San Francisco	3	....	2	2	....	6	6	10, 725, 000 00
Total	5	2	2	3	4	6	8	18, 875, 00 00

Estimate for submarine mines and their adjuncts.

Seaport.	Submarine mines.			Operating rooms, &c.		Electric lights, complete.		Grand total.
	In store.	Number needed.	Cost.	Number.	Cost.	Number of projectors.	Cost.	
New York	560	690	$241, 500	5	$50, 000	20	$120, 000	$411, 500
San Francisco	461	589	206, 150	7	120, 000	28	168, 000	494, 150
Boston	185	215	75, 250	5	50, 000	20	120, 000	245, 250
Lake ports	......	200	70, 000	4	40, 000	16	96, 000	206, 000
Hampton Roads	......	400	140, 000	2	20, 000	8	48, 000	208, 000
Mississippi River	......	150	52, 500	2	30, 000	8	48, 000	130, 500
Philadelphia	215	35	12, 250	3	30, 000	12	72, 000	114, 250
Washington	......	150	52, 500	2	20, 000	8	48, 000	120, 500
Baltimore	......	100	35, 000	1	10, 000	4	24, 000	69, 000
Portland	......	350	122, 500	4	60, 000	16	96, 000	278, 500
Narragansett Bay, both entrances	......	300	105, 000	2	20, 000	8	48, 000	173, 000
Key West	......	150	52, 500	1	10, 000	4	24, 000	86, 500
Charleston	......	150	52, 500	1	10, 000	4	24, 000	86, 500
Mobile	......	300	105, 000	1	15, 000	4	24, 000	144, 000
New London	......	150	52, 500	3	45, 000	12	72, 000	169, 500
Savannah	......	300	105, 000	3	45, 000	12	72, 000	222, 000
Galveston	......	150	52, 000	1	15, 000	4	24, 000	91, 500
Pensacola	......	200	70, 000	1	15, 000	4	24, 000	109, 000
Portsmouth	......	161	56, 350	2	30, 000	8	48, 000	134, 350
Ten minor ports defended by existing works	......	......	....	.....	....	.....	....	840, 000
Total	1, 421	4, 740	1, 659, 000	50	635, 000	200	1, 200, 000	4, 334, 000

Estimate for torpedo boats.

Locality.	Torpedo gunboats.		Torpedo gunboats.	Cost.
	Number of groups.	Number of boats.	Number	
1. New York	3	18	....	$1, 080, 000
2. San Francisco	3	18	....	1, 080, 000
3. Boston	3	18	....	1, 080, 000
4. The lake ports	....	....	12	720, 000
5. Hampton Roads	3	18	....	1, 080, 000
6. New Orleans	2	12	....	720, 000
7. Philadelphia	1	6	....	360, 000
8. Portland, Me	1	6	....	360, 000
9. Rhode Island ports in Narragansett Bay	1	6	....	360, 000
10. Key West	1	6	....	360, 000
11. Charleston, S. C	1	6	....	360, 000
12. New London	3	18	....	1, 080, 000
13. Portland, Oreg	3	18	....	1, 080, 000
Total	25	150	12	9, 720, 000

PRACTICAL MEASURES FOR OBTAINING THE APPLIANCES FOR DEFENSE.

There is no difficulty in procuring from the resources of our own country all the appliances for defense except guns and steel armor.

There are two, and only two, methods by which modern guns and armor can be procured. These are, first, by direct purchase from the immense establishments now existing abroad, or, second, by domestic manufacture.

The workshops of Europe, with all their facilities for turning out this material, are now fully occupied by the demands upon them. They are, in fact, expanding every day. Experience has shown that the few experimental orders already given from this country are filled only after long delays; and it is impossible to estimate the time required for the delivery of the large quantities we urgently need. Moreover, war would at once put a stop to such importations and leave us helpless in the emergency. The disbursement abroad of the large sums involved in these purchases would not be profitable to this country. On the other hand, if spent here, they would encourage home industries, promote the national wealth, and render our defenses independent of other countries. For these reasons the Board cannot too strongly condemn a resort to foreign purchases.

What, then, are the facilities for procuring these supplies in our own country?

None but the best crucible or open-hearth steel, possessing certain well-known physical qualities, is suitable for gun manufacture; and the ingots must be forged by hydraulic presses or under hammers of power far exceeding any here existing. The Board is entirely in favor of presses.

After a careful study of the extensive plant required for the production of steel-gun forgings and armor-plates of sizes, thicknesses, and qualities suitable for such manufacture, and after an inspection of our principal works and foundries, the conclusion is forced upon the Board that the necessary facilities for the production of such large masses of steel, and the machines for fashioning this metal into guns and armor, are not now to be found in this country.

At the Midvale Steel Works, Philadelphia, at the Cambria Steel Works, Johnstown, and elsewhere, plant is available for 6-inch and probably 8-inch forgings of a quality not surpassed by the best made abroad. But the 8-inch gun is the very smallest recommended for extensive use in our forts; so that, practically, this plant would have to be made anew to meet the demand for larger calibers.

It is clear that to effect the object of the act of Congress under which this Board was appointed, the manufacture and tempering of steel in enormous masses must be provided for by Congressional legislation.

The same can be said of the large and extensive workshops, and tools for machining the steel.

The Board, basing its estimates upon the report of the Gun Foundry Board, considered that, to accomplish the work and accomplish it well, the plant necessary for making the tempered steel for the parts of guns up to the largest calibers will cost about $850,000, and that the plant for fabricating such guns will cost about $900,000—this sum being exclusive of expenditures necessary to arm the Navy.

The vital question then arises, In what manner can such steel works and machine shops be best created?

It cannot be expected that even the richest and most flourishing of our steel works, with millions of capital to uphold it, will venture such an amount of money in plant, merely in the doubtful hope that the Government may give a contract sufficiently large to save it from loss.

Business men know that the action of one Congress does not control the action of subsequent Congresses, and that, unless the appropriation is made permanent, running through several years, pledging the United States to such an expenditure, there is no certainty as to the future, and the risk is far greater than the chances of profit.

After due consideration of the subject this Board indorses the conclusions of the Gun-Foundry Board, contained in the supplementary report of December 20, 1884, as follows, viz:

> The question whether the fabrication can be better and more economically performed in Government establishments, or by private contract, or by a combined system has been carefully considered, and the Board has been unable to discover any reason to modify the unanimous opinion expressed in its report of February 16, 1884, that "it is more judicious to establish gun factories"; that there should be "two gun factories under the control of the Government, and that the Army and Navy should be provided with separate establishments."

The requirements of the two services in this respect are sufficiently distinct to justify two separate establishments, which, in the interests of the national defense, would be fully occupied for many years to come—probably long enough to exhaust their capacity for good work.

An appropriation, therefore, of $1,000,000 for a factory is recommended, and should be made at once, as it would require about two years to erect and equip it. The money required for machinery and completing the guns at the factory could be appropriated in the following year, when the forgings would be about ready for delivery.

Again this Board quotes from and indorses the report of the Gun-Foundry Board:

> The Board repeats its unanimous opinion "that the steel manufacturers should be called upon to provide the material," and recommends—
>
> (1) An appropriation of not less than $15,000,000—one-half for the Army and one-half for the Navy—to remain available until expended; provided, however, that none of the money so appropriated shall be expended except in payment for steel accepted and delivered.
>
> (2) Proposals to be issued by the War and Navy Departments for bids for the supply of the steel required by each, rough-bored, rough-turned, tempered, and conforming to specifications. Said proposals shall divide the steel required into two lots. Each lot shall include all the parts for one-half of the number of guns of each caliber. Each bid must include all of a lot or lots. Each bidder shall agree to deliver yearly a specified quantity of each caliber, the time of delivery of the smaller calibers to commence at the expiration of not more than eighteen months, and that of the largest calibers at the expiration of not more than three years from the date of acceptance of the contract. Each bidder shall specify the price of the parts for each of the several calibers. This price may be modified by the Government in equity according to the current rates of labor and material.
>
> (3) Bids to be considered must be made by responsible parties, each of which shall certify and guarantee to erect in the United States a suitable plant capable of making all the steel required and of finishing it in accordance with the contract.
>
> From personal intercourse with prominent steel makers in the United States the Board is in a position to assert that proposals issued on the above basis will be responded to, but that it will be necessary to appropriate the entire amount recommended in order to induce *responsible* steel manufacturers to erect and complete the plants to produce the steel for the guns needed for national defense.
>
> The above proposition contains only such a guarantee as would be required by business men embarking in a new and expensive undertaking.

In the matter of procuring the needful supply of armor, the Board does not consider that specific recommendations are required. Armor plates of moderate dimensions can now be fabricated in this country, and the demand for steel armor for naval purposes, joined to that for guns, and perhaps for turrets, will, it is believed, afford all needful encouragement to induce our steel manufacturers to procure the plant.

RECAPITULATION OF ESTIMATES.

The following consolidated estimate presents the cost of defendin our entire sea-coast and lake frontier upon the plan recommended b the Board; and also that for defending the eleven ports where the expenditure is most urgently required. The cost of machine guns, ammunition, transportation, and for proving guns and armor is not included, because somewhat indefinite in character, although not ver great. The appropriations will be asked for as needed by the prope Departments:

Consolidated estimate.

	Port.	Land defenses.			Armament.		Floating batteries and their armament.	Submarine mines and their adjuncts.	Torpedo-boats.	Total.
		Masonry and earth-work.	Armor.	Structural metal.	Guns and mortars.	Carriages.				
1	New York	$5,488,000	$7,950,000	$1,000,000	$6,027,000	$1,992,000		$411,500	$1,080,000	$23,948,500
2	San Francisco	5,656,000	2,250,000	450,000	5,426,000	1,787,000	$10,725,000	494,150	1,080,000	27,868,150
3	Boston	2,214,000	3,100,000	330,000	2,971,000	970,000		245,250	1,080,000	10,910,250
4	The Lake ports	1,648,000	650,000	125,000	598,000	189,800		206,000	*720,000	4,136,800
5	Hampton Roads	1,632,000	2,200,000	230,000	1,608,000	534,000		208,000	1,080,000	7,492,000
6	New Orleans	1,200,000			1,130,000	380,000	8,150,000	130,500	720,000	11,710,500
7	Philadelphia	832,000	1,300,000	130,000	828,000	274,000		114,250	360,000	3,838,250
8	Washington	520,000			512,000	171,000		120,500		1,323,500
9	Baltimore	632,000	650,000	65,000	578,000	190,000		69,000		2,184,000
10	Portland, Me	2,096,000		200,000	1,784,000	587,000		278,500	360,000	5,305,500
11	Narragansett Bay	1,296,000	450,000	150,000	1,374,000	450,000		173,000	360,000	4,253,000
	Total of above 11 ports	23,214,000	18,550,000	2,680,000	22,836,000	7,524,800	18,875,000	2,450,650	6,840,000	102,970,450
12	Key West	1,064,000	450,000	150,000	976,000	320,000		86,500	360,000	3,406,500
13	Charleston	872,000		80,000	636,000	210,000		86,500	360,000	2,244,500
14	Mobile	1,872,000		80,000	858,000	284,000		144,000		2,738,000
15	New London	580,000		80,000	308,000	103,000		169,500	1,080,000	2,320,500
16	Savannah	652,000	650,000	65,000	492,000	162,000		222,000		2,243,000
17	Galveston	552,000			232,000	75,000		91,500		950,500
18	Portland, Oreg	849,000			671,000	219,000		100,000	1,080,000	2,919,000
19	Pensacola	520,000		40,000	208,000	71,000		109,000		948,000
20	Wilmington, N. C	640,000	650,000	105,000	335,000	112,000		100,000		1,942,000
21	San Diego	260,000			108,000	36,000		100,000		504,000
22	Portsmouth, N. H	420,000			308,000	103,000		134,350		965,350
23	Cumberland Sound	240,000		40,000	154,000	52,000		150,000		636,000
24	Kennebec River	120,000			81,000	27,000		70,000		298,000
25	New Bedford	152,000			167,000	58,000		150,000		522,000
26	Penobscot River	120,000			81,000	27,000		70,000		298,000
27	New Haven	236,000			103,000	33,000		100,000		472,000
	Grand total of 27 ports	31,863,000	20,800,000	3,320,000	23,554,000	9,411,800	18,875,000	4,334,000	9,720,000	126,377,800

* Torpedo gunboats.

A comparison can now be made of the estimates for modern works with those made in 1840, when the old system of coast defense had received considerable development and was being pressed toward completion. The population of the country at that time was 17,000,000, and the estimate of cost, including the amounts already expended, was $57,131,541, being at the rate of $3.35 per head.

The population in 1880 was 50,000,000, and the estimate for the coast defense is $126,377,800, at the rate of $2.52 per head.

The valuation of property in 1880 was $43,642,000,000; that of 1840 was about $4,000,000,000, and it is to be seen that the ratio of the estimate for defenses to the wealth of the country at the present time exhibits a still more favorable comparison.

In 1840 the cost of the line-of-battle ship, then representing the most formidable means of attack against coast defenses, was about $550,000, and the cost of the corresponding war ship of the present day is about $5,000,000. While the ships have increased in cost nine-fold, the estimate of the defenses to resist these has increased only between two and three fold.

Certain portions only of the whole amount above indicated as necessary are needed at once, viz:

A. An appropriation for gun steel sufficient to induce contracting steel works to prepare for and begin the manufacture of steel forgings for guns of all calibers, $8,000,000.

B. An appropriation for a gun factory with plant sufficient to machine, assemble, and finish the guns, $1,000,000.

C. An appropriation to inaugurate the building of masonry foundations, engine-rooms, shell-rooms, magazines, &c., necessary to the reception of the armor, guns, &c., $4,000,000 for the first year and $2,000,000 annually thereafter until completed.

D. An appropriation for armor and structural metal, $2,000,000 annually until completed.

E. An appropriation for gun-carriages, $1,000,000 annually until completed.

F. An appropriation for the building of floating batteries, the type to be selected by a joint board of Army and Navy officers, $3,000,000 for the first year and $2,000,000 annually until completed.

G. An appropriation for submarine mines and their adjuncts, $1,000,000 for the first year and $500,000 annually thereafter until completed.

H. An appropriation for building torpedo-boats, $1,500,000 annually until all are built.

Summing up these recommendations, the Board presents the following project for annual appropriations:

Appropriations recommended.

Purpose.	Appropriation for first year.	Future annual appropriations until work is completed.
A. Gun metal	$8,000,000	....
B. Gun factory	1,000,000	....
C. Masonry, &c	4,000,000	$2,000,000
D. Armor, &c	2,000,000	2,000,000
E. Gun-carriages	1,000,000	1,000,000
F. Floating batteries	3,000,000	2,000,000
G. Submarine mines, &c	1,000,000	500,000
H. Torpedo-boats	1,500,000	1,500,000
Totals	21,500,000	9,000,000

After mature consideration, and with all the information before it, the Board is of opinion and recommends that the above-named amounts should be appropriated by Congress without delay, for the purposes mentioned, and it further states that nothing less will suffice even for a beginning.

In order to enable the Department to carry out this large project without delay, it is suggested that the present laws requiring advertising for bids and making contracts should be materially modified. Contracts should be made to continue for a series of years, and smaller purchases should be made in open market. Under the present laws it is impossible at times to carry on the work intrusted to the Department, and not infrequently unnecessary expenditures arise without accruing advantages.

WM. C. ENDICOTT,
Secretary of War, President of the Board.
S. V. BENÉT,
Brigadier-General, Chief of Ordinance, U. S. Army.
JOHN NEWTON,
Brigadier-General, Chief of Engineers, U. S. Army.
HENRY L. ABBOT,
Lieutenant-Colonel of Engineers, U. S. Army.
CHAS. S. SMITH,
Captain of Ordnance, U. S. Army.
W. T. SAMPSON,
Commander U. S. Navy.
C. F. GOODRICH,
Commander, U. S. Navy.
JOS. MORGAN, Jr.
ERASTUS CORNING.

EDW'D MAGUIRE,
Captain of Engineers, U. S. Army, Secretary of the Board.
WASHINGTON, D. C., *January* 16, 1886.

RIVERS AND HARBORS, ETC.

APPENDIX A.

PROVEMENT OF RIVERS AND HARBORS IN THE STATES OF MAINE AND NEW HAMPSHIRE.

EPORT OF MAJOR JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- **Lubec Channel, Maine.**
- **Bangor Harbor and Penobscot River, Maine.**
- **Moose-a-bec Bar, Maine.**
- **Belfast Harbor, Maine.**
- **Rockland Harbor, Maine.**
- **Portland Harbor, Maine.**

7. Kennebunk River, Maine.
8. Breakwater at mouth of Saco River, Maine.
9. Saco River, Maine.
10. Portsmouth Harbor, New Hampshire.
11. Cocheco River, New Hampshire.

EXAMINATION AND SURVEY.

12. Saco River, Maine.

UNITED STATES ENGINEER OFFICE,
Portland, Me., July 26, 1886.

SIR: I inclose herewith annual reports for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

A 1.

IMPROVEMENT OF LUBEC CHANNEL, MAINE.

The situation and original condition of this channel was described in the last annual report, as follows:

> Lubec Channel forms the eastern boundary of the State of Maine, between the town of Lubec and Campobello Island. For a length of 2 miles (*i. e.*, from about 850 feet below the "Western Bar Beacon" to the head of "Lubec Narrows") it was obstructed by

bars having for the most part only 5 feet at mean low water, or 22 feet at mean high water, the mean rise and fall of the tides being 17 feet, while at *extreme* low water of spring tides there was but 1 foot over the shoalest parts. At and near mean low water, therefore, vessels were unable to pass through this channel, and were forced to make a detour some 16 miles longer through British waters in order to reach Lubec, Eastport, and the points in Maine on the Saint Croix and Pembroke rivers. The same loss of time and distance occurred on the return trip; vessels leaving the upper ports, necessarily about high water, reached the channel near low water.

At the beginning of the fiscal year a contract was outstanding with Messrs. Moore & Wright, of Portland, Me., for widening the new channel by dredging. Work under this contract was completed July 11, 1885, the amount dredged after July 1st being 5,792 cubic yards, scow measurement. The result of this work has been to add 48 feet to the width of channel in the lower bend, the depth of entire channel at mean low water being 12 feet.

The channel now has a clear width of 200 feet throughout, with a maximum width of 278 feet at the lower bend.

The present project, for which estimates were submitted in the annual reports for 1883 and 1884, contemplates the deepening of the channel to 15 feet at mean low water, and giving a clear width of 275 feet, with 300 feet at the bends. It has, however, been considered desirable to apply any available funds in such way as to give the entire width mentioned before undertaking the increase in depth, so that the estimate in the last annual report covered the increased width only.

To complete that portion of the project for increasing the width of channel requires the removal of about 69,000 cubic yards of material, measured in scows. While the channel now gives a depth of 12 feet at mean low water, the variations are so great that a minimum depth of 8 feet occurs at extreme low tides. No vessel can pass through drawing the extreme depth of water, and in such rapid currents as here obtain in a narrow channel, even the best steamers must have 2 or more feet of water under their keels to permit their handling with safety.

The benefits to navigation and to commerce from the improvement are not local. The channel forms a part of a thoroughfare to and from the Saint Croix River and the waters of the Passamaquoddy Bay, and is not only the shortest route and the only channel not exposed to the open sea, but is the only one in American waters through which vessels can reach many points on our eastern border.

During heavy gales many vessels find refuge and anchorage in the lower part of Quoddy Roads; in such cases, when the wind changes to the eastward there is no longer any protection, and no escape save by the Lubec Channel, which must afford a sufficient draught of water at all times to make it effective. Before the improvement was undertaken many vessels were thus hemmed in and wrecked. (See Report of Chief of Engineers, 1879, Appendix A, page 281.)

Save for use in the fisheries, the smaller vessels are gradually disappearing from the coast, as they cannot compete in the carrying of freights with vessels of larger capacity, so that deeper channels will be required in future than those heretofore necessary.

The recommendations previously made to dredge the channel to a depth of 15 feet are therefore renewed.

Owing to the range of tides, the rapid currents and fogs which are encountered, together with the small amounts heretofore made available for work in a single season and the remote situation, the average contract price for dredging in this channel has been 41.4 cents per cubic yard, scow measurement. The placing and maintenance of bumerous guide piles and other contingent expenses add a considerable percentage to the cost.

The original project for this improvement, submitted in annual report for 1879, was to give a clear width of 200 feet, throughout, and a a low water depth of 12 feet. The estimated cost was $48,000 (incorrectly printed in report as $47,000). This was made on a basis of 20 cents per cubic yard, for the material removed from the shoals, and 50 cents, per yard, for material in the narrows; the material in the narrows cost by contract $1 per yard, and the average price for the remainder has cost, by contract, more than twice as much for material measured in scows as was estimated for the same, *in situ*. For the reasons here given, the estimate was successively amended in 1880, 1881, and 1882, the last named placing cost of the original project at $154,000 (Report of Chief of Engineers, 1882, Appendix A 2, page 487). In 1883 it became apparent that the width of 200 feet was insufficient and that a greater depth was required, owing to the larger class and greater number of vessels attracted to the route. Upon the request of the International Steamship Company a project was submitted increasing the channel width to 275 feet, with an addition of 25 feet at the bends, and deepening the water to 15 feet. The estimated expense of this increase in width and depth was $113,000 (Report of Chief of Engineers, 1883, Appendix A 1, page 409). The estimate for increased width and depth of channel was based upon a price of 35 cents per cubic yard, measured *in situ;* this price will probably be found too small, the average price by contract having been heretofore nearly 42 cents, for material measured in scows, and the latter measurement exceeds that *in situ*, from 20 per cent. to 30 per cent. It should be added that the estimates have been necessarily based upon continuous work, the failure of which has tended largely to increase the contract prices, as well as the contingent expenses.

The following appropriations have been made for this work:

By act of March 3, 1879	$44,000
By act of June 14, 1880	20,000
By act of March 3, 1881	45,000
By act of August 2, 1882	20,000
By act of July 5, 1884	10,000
Total	139,000

The total expenditures to June 30, 1886, have been $139,000.

It is estimated that, to complete the project, there will be required the following amounts:

To complete the width, dredging 69,000 cubic yards (scow measurement), at 42 cents	$28,980
80 guide-piles, at $5	400
Engineering and contingent expenses	3,120
Total for channel 12 feet deep	32,500

The depths in the channel are somewhat irregular, so that, although but 12 feet of water are available, the amount in places is considerably greater. To increase this so as to give a low-water depth of 15 feet it is estimated will require dredging—

240,000 cubic yards, in scow, at 42 cents	$100,800
Dredging Narrows, 21,000 cubic yards, *in situ*, at $1	21,000
140 guide-piles, at $5	700
Engineering and contingent expenses	12,500
Total	135,000

Of the above amounts $50,000 could be advantageously expended in one year.

Lubec Channel is situated in the collection district of Passamaquoddy. The nearest port of entry is at Eastport, Me., about 3 miles above, at which place Fort Sullivan is situated. The nearest light-house is on West Quoddy Head, about 4 miles below.

The appended letter received in reply to inquiries from this office cover all the commercial statistics which can at present be obtained.

Money statement.

July 1, 1885, amount available	$3,039 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,039 29
Amount appropriated by act approved August 5, 1886	10,000 00
Amount (estimated) required for completion of existing project	157,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM HOUSE, EASTPORT, ME.,
Collector's Office, April 8, 1886.

Statement of American and foreign vessels arrived and cleared, imports and exports, and number of vessels built in the district during the year ending December 31, 1885.

Shipping.	Number.	Tonnage.
American vessels arrived from foreign ports	385	167,221
American vessels cleared for foreign ports	426	171,358
Foreign vessels arrived from foreign ports	258	12,950
Foreign vessels cleared for foreign ports	258	12,950
Vessels built	2	16

Value of exports	$405,312
Value of imports	576,651

N. B. NUTT,
Collector.

A 2.

IMPROVEMENT OF BANGOR HARBOR AND PENOBSCOT RIVER, MAINE.

Various improvements have been made to the navigation of the Penobscot River since 1870, under appropriations made in the following acts of Congress:

Act approved July 11, 1870	$15,000
Act approved March 3, 1871	50,000
Act approved July 10, 1872	40,000
Act approved March 3, 1873	20,000
Act approved June 23, 1874	20,000
Act approved March 3, 1875	25,000
Act approved August 14, 1876	10,000
Act approved June 18, 1878	12,000
Act approved March 3, 1879	6,000
Total	198,000

On the 1st July, 1880, the entire amount of the above appropriations had been expended, and the projects were completed.

No original project was ever made comprising all the improvements for which appropriations were made and expended; but various projects were carried out as the occasion arose. A summary of the work accomplished was given in Annual Report for 1880, as follows:

1. To straightening, deepening, and widening the channel through the several shoals at Bangor and below for a distance of 3¼ miles, so as to have a width of not less than 200 feet and a depth of not less than 11 feet at low water (or 25 feet at high water) in its *lowest* stages, giving about 14 feet at low water in its ordinary stages.

2. To breaking up and removing all the sunken ledges and bowlders in the harbor of Bangor outside the main channel down to the level of the general bed of the river, including Independence Rock, Gulliver's Rock, the ledge near steamboat wharf, and those near Dole's Wharf, Green's Pier Ledge, and a ledge outside of it; also the ledges and bowlders in front of the wharves at High Head. The accompanying sketch of Bangor Harbor shows the several improvements made in that harbor, but not those below, near Stearn's Mill, in Hampden.

3. To removing by dredging the middle ground in Bucksport Harbor, 18 miles below Bangor, to a depth for the most part of 12 feet at mean low water, as shown on the accompanying sketch of the same.

The work carried on for the improvement of this river during the fiscal year ending June 30, 1880, has been applied to the completion of the removal of all sunken ledges in front of High Head Wharves, under an extended contract made August 7, 1878, with Mr. Isaac Hamilton, of Portland, Me. This work was commenced by him on the 11th of July, 1879, and continued without interruption until its completion on the 31st of October, 1879, whereby all the work hitherto projected for the improvement of this river, both at Bangor and Bucksport, has been completed, so that no further appropriation is asked therefor.

In the river and harbor act of 1882 a survey was ordered with special reference to the improvement of the river near Bangor, Me., and a special report on the subject was printed in Senate Ex. Doc. No. 44, Forty-eighth Congress, first session (see Report of Chief of Engineers for 1884, Appendix A, page 476). The improvement was to widen the channel opposite Bangor, and at Crosby's Narrows, 3½ miles below. The amount estimated to complete the improvement recommended was $75,000.

The act of July 5, 1884, appropriated for the purpose the sum of $20,000. Proposals for the dredging received and opened on the 28th of April, 1885, were rejected as too high. Advertisements were again issued June 20, 1885, and new proposals were opened July 13, 1885. A contract for dredging 40,000 cubic yards, more or less, at 36 cents, was made July 20, 1885, with Messrs. Moore & Wright of Portland, Me. The work was commenced August 15 and completed November 15, 1885.

Under this contract the channel in harbor of Bangor was widened 100 feet by dredging on the east (Brewer) side for a length of 2,728 feet, the excavation being made to a depth of 11 feet at extreme low water. The total amount expended for the purpose has been $19,950.68. The resulting channel for navigation and anchorage is 300 feet in width, so that the handling of vessels can now be accomplished with vastly greater convenience and safety than before. The numerous rafts of lumber, sailing vessels, steamers, and tows make it essential that the channel should be wide, and the completion of the last project is therefore recommended.

The further work contemplated consists in completing the widening of channel at Bangor, and increasing the width at Crosby's Narrows. It is believed that the work may be accomplished for the amount originally estimated, viz, $75,000, less the amount appropriated by act of July 5, 1884, $20,000, thus requiring a further appropriation of $55,000.

The benefit to commerce and navigation from the improvements made and contemplated is believed to be large, but available statistics are incomplete. In addition to statistics given, there are many vessels navigating the river no account of which has been obtained.

An official pamphlet published by the Bangor Board of Trade in 1883 gives very full statistics for that date. (See Report of Chief of Engineers for 1884, Appendix A, page 477.)

The nearest port of entry for portion of the river here considered is Bangor, Me. The commercial statistics for the year ending December 31, 1885, are given in the appended letter from the collector of customs at Bangor, Me.

Money statement.

July 1, 1885, amount available	$19,966 54
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	19,917 22
July 1, 1886, amount available	49 32
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,049 32
Amount (estimated) required for completion of existing project	40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received July 13, 1885, *for dredging* 40,000 *cubic yards, improvement of Bangor Harbor, Maine.*

Names and addresses of bidders.	Price per cubic yard measured in scow.	Remarks.
Boynton Brothers, Boston, Mass	$0 50	Contract made July 20, 1885.
Moore & Wright, Portland, Me	0 36	
Bay State Dredging Company	0 37½	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, BANGOR, ME.,
Collector's Office, April 3, 1886.

SIR: I have the honor to acknowledge the receipt of your letter of the 29th ultimo, requesting me to furnish you certain information in regard to revenue collected in this district, exports, imports, entries, and clearances of vessels, &c. In compliance with your request I give you below, as near as may be, the information you desire for the year ending December 31, 1885:

Amount of revenue collected (duties)		$63,220 29
Value of exports		188,375 00
Value of imports (dutiable)		279,846 00
Value of imports (free)		424,931 00
American vessels arrived from foreign ports, 5	tons	1,719
Foreign vessels arrived from foreign ports, 16	do	2,924
American vessels cleared for foreign ports, 29	do	10,499
Foreign vessels cleared for foreign ports, 26	do	5,589
Vessels built, 1	tons net	117.06
Vessels rebuilt, 1	do	55.65

Arrivals and departures coastwise are not reported at the custom-house, as no reports of the movements of coastwise vessels is required by the Department, neither is the number of crew required to be furnished in foreign-going vessels.

By an examination of the harbor-master's records the number of arrivals of vessels in the coastwise trade during the year appears to be in the near vicinity of 2,000; departures the same, as all vessels leave at the closing of the river.

Very respectfully,

D. F. DAVIS,
Collector.

A 3.

IMPROVEMENT OF MOOSE-A-BEC BAR, MAINE.

Moose-a-bec Reach is a thoroughfare of about 12 miles in length between the islands and mainland, the western extremity being about 30 miles east of Mount Desert, Maine. By its use the distance navigating the coast is somewhat shortened, in addition to the great benefit afforded by a sheltered channel and refuge in storms. The only obstructions to the safe navigation at all stages of tide are the bar and a few small ledges at the eastern extremity of the reach.

In the Annual Report of Chief of Engineers for 1880 (page 358, Appendix A), a project and estimate was submitted for dredging the bar to obtain 14 feet at mean low water over a width of 200 feet and a length of about 1,900 feet. The expense was estimated at $28,000. In 1881 and 1882 the project was revised and the estimate for the work was made $40,000.

The following appropriations have been made by Congress for carrying on the work:

By act of March 3, 1881	$10,000 00
By act of August 2, 1882	10,000 00
By act of July 5, 1884	10,000 00
Total	30,000 00
Total expenditures to June 30, 1886	29,946 34

On the 20th of June, 1885, proposals were invited for dredging under the appropriation of July 5, 1884. But two proposals were received. They were opened on the 13th of July, and a contract was awarded to Messrs. Moore & Wright, of Portland, Me., at 38 cents per cubic yard, measured in scows. Under this contract work was commenced July 22, 1885, and was completed September 16, 1885. The amount of material removed was 23,345½ cubic yards. The amount expended for the last fiscal year was $9,973.38.

By this work the channel was increased in width from 141 feet to 200 feet, thus entirely completing the dredging originally proposed, but leaving the ledge to be removed in the future. To complete the project heretofore submitted, the estimate as taken from the last annual report is $10,000.

The benefits thus far to the navigation of the coast have been very great, so that large numbers of vessels, as well as the regular lines of sea-going steamers, constantly use the new channel.

It will be readily seen that a channel of 200 feet in width is insufficient for sailing vessels with adverse winds, and that in the night and in foggy weather the difficulties are increased.

It is earnestly desired by the owners and masters of vessels plying the thoroughfare that the channel over the bar be increased to 300 feet in width, and that the small ledges in the reach near the bar should be removed.

The large amount of commerce to be benefited fully justifies a recommendation that the increased width be made and the adjacent ledges removed, as desired.

When the tides are ebbing a current flows through the channel from east to west in the direction of its length, but when the flood tide sets in, a very strong current passes through the old channel across the bar from southwest to northeast, until a height of about four feet above low water is reached, when after a short interval the direction of the current changes to the same direction as in the ebb tides. This movement

of the tides makes the navigation of the channel by sailing
light winds very difficult.

The most obvious method of remedying the difficulty is by
ing a small breakwater of riprap stones across the old cha
Nova's Rocks to the present location of the buoy on Pile
Ledge, at the edge of the new channel. The height of the b
needs to be but two feet above low water (the principal stren
current being while the water is below that stage). The ex
of the breakwater should be raised with large stones, forming
to replace the buoy which now marks the ledge.

Accompanying this report is a map of Moose-a-bec Bar and
diate surroundings, the soundings being shown only where th
mean low stages has a depth of less than 14 feet.

The area to be dredged to give the channel the width recom
the location of the small breakwater and the small ledges
moved, are all indicated on the map by shading with parallel

The pier at the end of the breakwater should be made
larger than indicated in the drawing upon the map. It is pos
the increased width of the channel may so change the curr
obviate the necessity for constructing the breakwater.

It is proposed to apply any funds appropriated for the purp
to widening the channel as indicated; second, to removing
ledges lettered on the map C, D, EE, F, G, H, and I; and thir
structing the small breakwater, if then found necessary.

The following estimate is submitted:

To widened channel, 65,000 cubic yards (scow measurement), at 35 cents....
For constructing breakwater and beacon....
Removing ledges....
Engineering surveys and contingent expenses....

The improvement is in the collection district of Machias. The nearest por
is at Machias, Me. The nearest light-house is Moose Peak.

The route being a regular thoroughfare to and from numerou
exact statistics are difficult to obtain. Some thousands of ves
several regular lines of steamers pass over the route annually.
appended letter from the collector of customs at Machias, Me., giv
only exaet statistics now attainable.

Money statement.

July 1, 1885 amount available....	$10,
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885....	9,
July 1, 1886, amount available....	
Amount appropriated by act approved August 5, 1886....	10,
Amount avalable for fiscal year ending 30, 1887....	10,

Abstract of proposals received July 13, 1885, for dredging 20,000 cubic yards, impr of Moose-a-bec Bar, Maine.

Names and addresses of bidders.	Price per cubic yard measured in scow.	Remar
Boynton Brothers, Boston, Mass....	$0 45	
Moore & Wright, Portland, Me....	0 38	Contract July 20,

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, MACHIAS, ME,
Collector's Office, April 8, 1886.

Sir: In reply to the inquiries contained in your letter of the 29th ultimo, I have the honor to furnish you the following information in regard to the custom-house siness of this district for the year ending December 31, 1885:

Amount of revenue collected:

ties, hospital dues, fines, &c	$306 35
cial fees	1,404 80
Total	1,711 15
ue of exportations	60,558 11
ue of importations	2,623 16
ber of American vessels arrived from foreign ports	4
nage of same	640
ber of foreign vessels arrived from foreign ports	5
nage of same	967
ber of American vessels cleared for foreign ports	170
nage of same	27,665
ber of foreign vessels cleared for foreign ports	7
nage of same	967
ber of vessels entered coastwise	14
nage of same	3,263
ber of vessels cleared coastwise	4
nage of same	963
ber of vessels built	4
nage of same	961.74

s we are not now obliged to keep a record of the number of the crew, I am unable give that. As most of the vessels which come into and go from this district are ler coasting license, and not required to enter and clear, the custom-house records w but a small part of the coastwise business.

Moose-a-bec Reach is a thoroughfare used by a large fleet of coasting vessels, and improvement of the bar must be of great advantage to them and also to the steam- running between Portland and Machiasport.

Very respectfully,
J. L. PIERCE,
Collector.

Maj. JARED A. SMITH,
Corps of Engineers.

A 4.

IMPROVEMENT OF BELFAST HARBOR, MAINE.

Appropriations have been made by Congress for improving this harr as follows:

t of August 14, 1876	$5,000
t of June 18, 1878	12,000
t of March 3, 1879	5,000
t of June 14, 1880	3,000
Total	25,000

The total amount expended to June 30, 1886, was $22,193.20, leaving a balance of 806.80.

The work accomplished has been the removal of ledges and shoals as to give not less than 10 feet depth at mean low water in the upper rtion of the harbor, and from 11 to 12 feet in the lower portion on the lfast side.

Some deepening of the water on the side of channel opposite Belfast desirable, but the amount available has been too small to make it adsable to undertake a contract for that work alone.

A small survey was made in the harbor in January, 1886.

It is recommended that the available balance be expended for the purpose indicated, as soon as an opportunity is afforded to do the work without too great an expense for towing dredges to and from the place. No expenditures except as mentioned are now proposed, so that no appropiation is asked.

In the autumn of 1885 a small schooner, known as the Waldemar, was sunk in the harbor. The removal of the wreck was directed by letter from Office of Chief of Engineers, dated January 25, 1886.

Advertisements for proposals were issued on the 10th of February, 1886. On the 22d of March a contract for removing the wreck was made with Mr. Solon S. Andrews, of Biddeford, Me. The work of removal was completed on the 12th of April, 1886.

The entire expense of removing the wreck, amounting to $537.12, was paid from the Treasury under the act of June 14, 1880, making appropriation for "removal of sunken vessels or craft obstructing or endangering navigation." It is, therefore, not included in account of expenditures for this harbor.

The harbor is situated in the district of Belfast, Me. The nearest port of entry is at Belfast. No commercial statistics have been received.

Money statement.

July 1, 1885, amount available	$2,843 05
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	36 25
July 1, 1886, amount available	2,806 80

A 5.

IMPROVEMENT OF ROCKLAND HARBOR, MAINE.

The river and harbor act of June 14, 1880, appropriated the sum of $20,000 for improving the harbor at Rockland, Me.

Later in 1880 four projects were discussed for the construction of breakwaters for protection of the harbor, the estimated expense for the plan adopted in 1881 being originally $500,000. This was revised in 1882, making the estimate $550,000. The plan adopted contemplates, first, the construction of a breakwater running somewhat east of south from Jameson's Point, a distance of 1,900 feet, and, after the completion of the first breakwater, to construct a second, commencing at a point about 1,300 feet southwest of the extremity of the first, and extending 2,640 feet in a direction slightly west of south to a point known as South Ledge (see map opposite page 464, Report of Chief of Engineers, 1881, Appendix A).

There have been appropriated by Congress for this purpose the following sums, viz:

By act of June 14, 1880	$20,000 00
By act of August 2, 1882	40,000 00
By act of July 5, 1884	40,000 00
Total	100,000 00
The total expenditure to June 30, 1886, has been	97,921 99

On the 1st of July, 1885, a contract was outstanding with Mr. Thomas A. Rowe, of Newton, Mass., for placing stone in the breakwater. Work under the contract was completed December 31, 1885. There were delivered in the breakwater, under the contract mentioned, 39,959 tons of stone, adding 473 feet to the length of breakwater, thus making the total length measured on top, at 5 feet above mean low water, 1,472 feet.

Correspondence received in this office raises the question of continuing the present breakwater to a greater length, rather than to construct the second one as proposed. The expense need not thereby be increased. The plan is one which may be better considered when the present breakwater is near completion. No recommendation for modification is therefore submitted in this report.

It is proposed to apply the present small balance of funds, together with any further appropriations, first, to complete this breakwater as designed, and second, to construct the further work as already described.

The protection now afforded by the breakwater is greatly dimished by the fact that it is at present entirely submerged about twelve hours of each twenty-four, so that the seas pass over its top. It is very desirable that the breakwater be raised to its entire height as soon as practicable.

The breakwaters are not only for the purpose of affording a protection to the shipping which may visit the harbor of Rockland, but also for forming a secure harbor of refuge for vessels upon Penobscot Bay and the adjacent coast. It is therefore for the benefit of the general commerce, of which the local statistics indicate but a small part.

The nearest port of entry is Rockland. The collection district is Waldoborough, Me. The nearest light-house is Owl's Head, 2 miles distant.

The statistics of entries, &c., at the custom-house are given in a letter, hereto appended, from the collector of the port.

Money statement.

July 1, 1885, amount available	$17,312 79
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	14,390 80
July 1, 1886, amount available	2,921 99
Amount appropriated by act approved August 5, 1886	22,500 00
Amount available for fiscal year ending June 30, 1887	25,421 99
Amount (estimated) required for completion of existing project	427,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, WALDOBOROUGH, ME.,
Collector's Office, April 19. 1886.

SIR: In conformity with your request, by letter of March 29, 1886, I am able to furnish you information relating to the port of Rockland, as follows, for the year ending December 31, 1885:

Amount of revenue collected	$2,832 73
Value of importations (about)	75,000 00
Value of exportations	Nominal

Shipping.	No.	Tons.	Crew.
American vessels entered from foreign ports	8	765.00	51
Foreign vessels entered from foreign ports	368	27,675.00	1,656
American vessels cleared for foreign ports	21	5,276.00	150
Foreign vessels cleared for foreign ports	369	27,762.00	1,661
Entries, coastwise	8	1,109.00	36
Clearances, coastwise	9	2,979.00	62
Vessels built in collection district	6	3,569.04	....

I should state, perhaps, that the coastwise entries and clearances recorded at the custom-house convey no accurate impression of the vessels arriving at and departing from the port of Rockland, the numbers of which cannot be arrived at by any means, but must reach, I should judge, as high as 4,000 to 6,000. Among these are steamers of the Boston and Bangor lines, daily in summer, usually four trips per week in winter; also, the Portland, Mount Desert, Blue Hill, Fox Island, and other steamers. The harbor is spacious, with good water and secure holding ground.

The breakwater has already improved its security as a harbor of refuge, and when completed will be of vast advantage, and amply justify the wisdom of its construction.

Very respectfully,

EDWIN SPRAGUE,
Collector.

JARED A. SMITH, Esq.,
Major of Engineers.

A 6.

IMPROVEMENT OF PORTLAND HARBOR, MAINE.

For a full history of the improvement of Portland Harbor, Maine, previous to 1879, reference is made to Report of Chief of Engineers for 1879, Appendix A, page 255.

From 1836 to 1879 there was appropriated for this harbor the sum of $351,447.05. Since that date the following appropriations have been made, viz:

By act of March 3, 1881	$20,000 00
By act of August 2, 1882	35,000 00
By act of July 5, 1884	30,000 00
Total	436,447 05
Of this amount there had been expended to June 30, 1886, the sum of	434,582 05

On the 1st of July, 1885, an unexpended balance of $8,326.29 remained for expenditure.

No definite complete project has ever been adopted covering all the improvements, but numerous small improvements have been made from time to time as they seemed to be required.

Between the harbor commissioner's line and the channel in the portion of harbor from Brown's Wharf to Franklin Wharf the bottom has for some years been in irregular shoals, one of which gave but about 12½ feet at mean low water. The shallowness of the water was found to be a serious obstruction to the movements of loaded vessels. It was also found that the larger class of steamers using the lower portion of the harbor were put to inconvenience, delay, and expense, from the lack of room in deep water. A project to remove the shoals to a depth of 17 feet, and to extend the area heretofore dredged to 21 feet, was submitted and approved in March, 1886.

Advertisements for proposals were issued April 10, and the bids received were opened May 1, 1886. A contract for doing the work was let to Messrs. Moore & Wright of Portland, Me., at 28 cents per cubic yard measured *in situ*. The work of dredging was commenced on the 18th of May. The dredging of the upper shoals was completed June 25, and the work of increasing the area giving 21 feet of water was commenced. At the end of the fiscal year the total amount removed under the contract was 19,890 cubic yards.

On the 7th of May, while acting as inspector, superintending the dredging, Mr. Carl Berrer, who had been for twelve years employed in this office as draughtsman and assistant engineer, was so severely injured by the breaking of a chain on the dredge that he died on the following day. By his death the Government has lost a most faithful and competent servant, and one who was highly respected wherever known.

Work under the contract will be completed in two weeks, and will accomplish all for which recommendations have been heretofore submitted.

Although the work of removing the shoals &c., under the last contract has been comparatively small, yet its benefits cannot fail to be felt by the greater ease with which loaded vessels may approach the wharves at low water.

It has for some years been apparent that the carrying of freights is much cheaper in large than in small vessels, and that in order to maintain the present commerce of Portland, as well as to encourage and foster new enterprises, a depth of water must be procured in the harbor which will accommodate at all times the largest transatlantic steamers and sailing vessels.

In view of these facts, the board of trade and parties interested have taken measures to represent the matter to Congress, with a view to obtaining a depth of 29 feet of water. The necessity for increasing the depth of water to at least 27 feet has been urged in letters to this office from the Dominion Line and Allan Line of steamship companies, of which this is the port from October until May.

A second improvement, which would add greatly to the convenience of vessels entering and leaving, as well as to the ease and security of lying at the wharves, is the extension of the breakwater on Stamford's Ledge, a distance of 1,000 feet, so that it may reach a depth of 18 feet at mean low water close to the point of departure by which the harbor is made or cleared.

I am informed that at certain times the seas setting into the harbor are greatly detrimental, and occasionally so hazardous to vessels at the lower wharves that they are compelled temporarily to leave and lie at anchor. The end of the present breakwater reaches a depth of but 4 feet at mean low water, and the turning point on its prolongation is marked by a buoy. In leaving the harbor it is necessary to find this buoy in order to shape a course which shall clear the points of ledges beyond. The varying tidal currents often make it difficult to find the buoy in fogs or at night, the times at which definite marks are indispensable, and when it is imprudent to get near the light on the end of the breakwater, owing to the shallow water and surrounding ledge.

In 1873 the channel in the back cove of Portland Harbor was improved by dredging a portion to a depth of 8 feet at mean low water. The desirability of a further increase of width and depth in this channel led the city council to consider the subject, and in April, 1886, a petition was forwarded to Hon. T. B. Reed, Representative in Congress, asking that measures be taken to obtain an appropriation for the purpose. The petition being referred to this office for a report and estimate, the subject was as fully considered as was practicable without a regular survey, and the result, with an estimate of cost, was submitted to the

Chief of Engineers in a letter dated May 4, 1886 (printed in Senate R port No. 1391, Forty-ninth Congress, first session). A copy of the lett is appended, to form part of this report.

A small map of the harbor of Portland, Me., accompanies this report and upon it are indicated the various improvements heretofore made and also that for which a project was submitted to Congress at its las session, as well as further improvements to the channel and breakwate which are recommended for future consideration.

1st. For a channel 500 feet wide and 29 feet deep, approaching th lower wharves of the harbor. This will require the removal of

635,000 cubic yards *in situ*, at an estimate of 20 cents per yard	$127,0
Contingencies, say	8,0
Total	135,0

A project for this improvement was submitted in a letter from thi office, dated December 11, 1885; the estimate of cost, however, was base upon prices lower than have heretofore been obtained. The estimat here submitted is therefore made on the basis of prices which see probable when judged from past experience.

2d. The dredging a channel 300 feet wide and 25 feet deep is recom mended, to connect the deep channel below with deep water in the uppe part of harbor. This will require the removal of

175,000 cubic yards of material, at an estimated cost of 20 cents per cubic yard	$35,0
Contingencies, say	3,5
Total	38,50

3d. Extending the breakwater 1,000 feet. It is estimated that thi will require—

75,000 tons of stone (quarry grout) at $1	$75,00
913 linear feet of superstructure, at $25 per foot	22,8
Pier for light-house on end of breakwater	12,00
Engineering and contingent expenses	10,175
Total	120,00

4th. Dredging channel in Back Cove 300 feet wide and 12 feet deep with winding basin:

721 cubic yards *in situ*, at 25 cents per cubic yard, including all contingencies	$180,

The harbor is in the collection district of Portland and Falmouth, Me. There is light-house on the breakwater, and at Portland Head, 3 miles distant. The harbor i defended by forts Preble, Gorges, and Scammel, and battery at Portland Head.

Money statement.

July 1, 1885, amount available		$8,326
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,941 37	
July 1, 1886, outstanding liabilities	4,519 92	
		6,461
July 1, 1886, amount available		1,865
Amount appropriated by act approved August 5, 1886		30,000
Amount available for fiscal year ending June 30, 1887		31,865
Amount (estimated) required for completion of existing project		105,000
Amount that can be profitably expended in fiscal year ending June 30, 1888		105,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received May 1, 1886, *for dredging* 29,641 *cubic yards, and for driving guide-piles for same.—Improvement of harbor at Portland, Me.*

Bidders.	Residence.	Price per cubic yard measured in situ.	Price per pile driven in position.	Remarks.
Robert Hamilton	Chebeague, Me	$0 31	$25 00	
Solomon Sawyer	Yarmouth, Me			
Moore & Wright	Portland, Me	28	20 00	Contract made May 10, 1886.

COMMERCIAL STATISTICS.

The following commercial statistics are taken from a letter from the collector of the port; additional statistics are given in my report of May 4, 1886, appended, for the year ending December 31, 1885:

Shipping.	Number.	Tonnage.
Arrivals:		
Foreign	273	135, 848
Coastwise	481	392, 313
Clearances:		
Foreign	397	200, 201
Coastwise	315	332, 401
Vessels built in the district	3	1, 844

Amount of revenue collected	$782, 501 99
Value of imports	6, 730, 034 00
Value of exports	9, 093, 574 00

IMPROVEMENT OF NAVIGATION IN THE BACK COVE, PORTSMOUTH HARBOR, NEW HAMPSHIRE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., May 4, 1886.

GENERAL: In accordance with request in indorsement of the Chief of Engineers, dated April 21, 1886, upon letter of Hon. T. B. Reed, inclosing petition from city government of Portland, Me., I have to submit the following report upon the necessity for improvement of navigation in the Back Cove of Portland Harbor, with a project and estimate of cost.

The petition mentioned recites certain statements regarding the limited harbor frontage available for miscellaneous purposes of commerce, and the necessity for making additional room by improving the channel in what is locally known as Back Cove; these statements are undoubtedly correct.

A reference to the map of Portland and its surroundings will show that it is situated upon a peninsula, and that owing to various obstacles the frontage occupied by wharves covers only a portion of one side. The peninsula itself is principally a high ridge, with bluffs at its extremities of 150 and 160 feet above the sea level. The growth of the city is of necessity in a direction away from the present harbor, so that at least one-half of the city and all of the immediate suburbs must be supplied with all heavy articles arriving by water at a large additional expense for cartage and handling, which must be paid by consumers of these articles, wherever located. While this no doubt gives employment to a few truckmen and laborers, yet it is a tax upon the industries, thrift, and commerce of the place.

The managers of railroads reaching this point have seen this di and for their own benefit have completely encircled the city an stations on either side, but the natural highway upon the water rear of the city is so poor that it is only used to a very limited and then with only partial benefit.

This report has been delayed somewhat in order to obtain r information upon which to base an estimate of probable benefits derived from the improvement, if made.

I am informed by Mr. M. N. Rich, secretary of the merchan change and board of trade, that in the year 1885 there were re or shipped by sea at this port the following heavy articles, the a being given as a close approximation: Coal, 300,000 tons; salt, 27,3 pounds; lumber, 39,085,476 feet; lime, 50,000 casks; fish, 81,617 sugar, 30,828,496 pounds; molasses, 1,292,997 gallons; oils, 25,00 rels; cement, 21,000 casks; ice, 30,000 tons.

While absolute figures are not easily obtained in advance it i reasonable to estimate that if one-half the coal could be handled o opposite side of the city by means of harbor facilities in the Back it would effect a saving of 25 cents per ton, amounting to an a benefit of $37,500 upon this single item.

The expense of handling other heavy articles would be simi affected to a greater or less extent, so that the total benefit coul fail to be very great.

Adjacent to the Back Cove and to the city in the town of Deeri a manufactory of stoneware, pottery, &c. Messrs. Winslow & Co proprietors, have at my request given me a statement of their rec and shipments by water, in a letter which is appended hereto. In single industry the saving upon 14,350 tons of crude materials recei such as clay, sand, and coal, is estimated as between $3,000 and $5, being approximately 21 cents to 34 cents per ton.

A study of the subject makes it apparent that an improvement of channel in the Back Cove will result in cheapening the transporta of a very large amount of material both for local and general consu tion.

I forward in a separate package a Coast-Survey chart of Portl Harbor, upon which is indicated the location of a marginal way w the city has undertaken and partly constructed, and of flats which to be filled. *A harbor commissioner's line* has been established 200 outside of and parallel to the "marginal way."

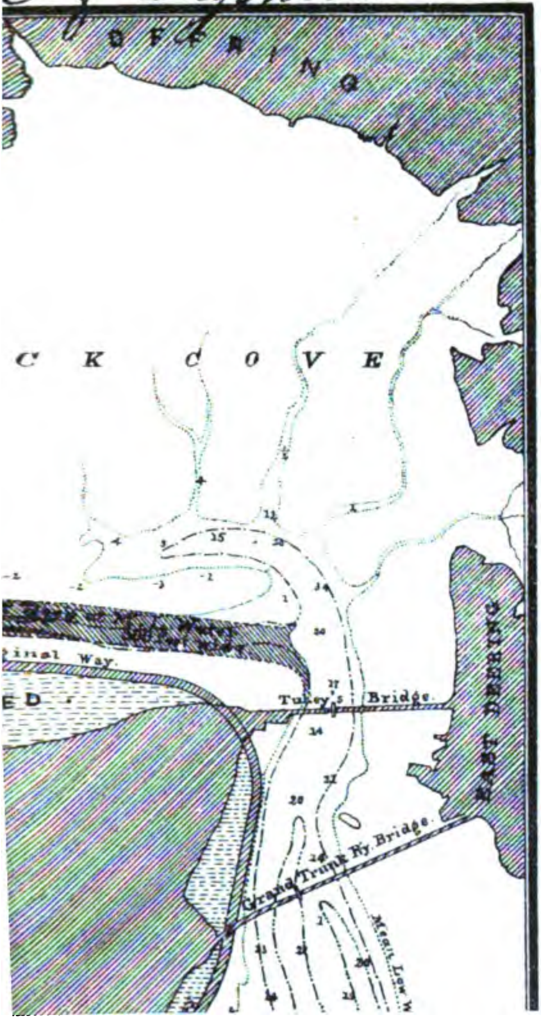
The project recommended is to deepen and straighten the channel that it may have a depth of not less than 12 feet at mean low wat and so that the inner edge may border the commissioners' line. Th channel may at first be made as narrow as 50 feet with a view to s sequent increase as the increasing traffic and commerce may dema A winding basin should, however, be constructed at the extreme e to permit the turning of vessels.

The improvement would consist entirely of dredging, the quantiti for which have been computed as accurately as possible from inform tion at hand, without incurring the expense of a survey.

Estimating for a channel of 12 feet in depth, which will be sufficie for the present needs, the quantities to be removed are as follows:

For a channel 50 feet wide, with basin, 200,000 cubic yards.
For a channel 100 feet wide, with basin, 299,500 cubic yards.
For a channel 150 feet wide, with basin, 396,000 cubic yards.
For a channel 200 feet wide, with basin, 500,000 cubic yards.
For a channel 250 feet wide, with basin, 617,000 cubic yards.
For a channel 300 feet wide, with basin, 721,000 cubic yards.

of Engineers



If done by contract the price cannot be safely estimated (including contingent expenses) at less than 25 cents per yard. This will make the estimated cost as follows:

For a channel 50 feet wide	$50,000
For a channel 100 feet wide	74,875
For a channel 150 feet wide	99,000
For a channel 200 feet wide	125,000
For a channel 250 feet wide	154,250
For a channel 300 feet wide	180,250

The channel of 300 feet in width is probably as small as will meet the ultimate requirements, and if this can be done by a machine and tug owned by the Government the cost would be greatly reduced, besides leaving the plant for use at other places. For this I would submit the following estimate, viz:

For dredge scow and tug	$50,000
Removing 721,000 cubic yards, at 10 cents	72,100
Total	122,100

Experience and observation indicate that the prices last given are ample to cover every expense when the work is done by labor and machinery employed directly by the Government.

If from the total amount the value of machinery left on hand for sale, or for use at other places be deducted, the cost of the entire improvement may be fairly estimated not to exceed $100,000.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

Money statement.

Amount appropriated by an act approved August 5, 1886	$26,250
Amount available for fiscal year ending June 30, 1887	26,250
Amount (estimated) required for completion of existing project	153,750
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000

A 7.

IMPROVEMENT OF KENNEBUNK RIVER, MAINE.

A history of this improvement was briefly stated in the last Annual Report. No appropriation has been made for the improvement since 1881. No work was carried on during the last fiscal year, and no further improvements are at present contemplated. A balance of $336.34 of the appropriation for the work remains unexpended, with which small repairs may be made should they be found necessary.

Improvements at this place were begun under an act of Congress of 1798. The work subsequently built consisted of two stone piers, supplemented by crib-work and wings for holding the sand.

The entire amount appropriated for improvement of Kennebunk River from 1870 to 1881 was $21,000. Of this there has been expended to the 30th June, 1886, $20,660.66.

The river lies in the collection district of Kennebunk. The nearest port of entry is Kennebunk.

There are no commercial statistics at present available to report.

Money statement.

July 1, 1885, amount available	$336 3
July 1, 1886, amount available	336 3

A 8.

BREAKWATER AT MOUTH OF SACO RIVER, MAINE.

The object of this work is to prevent the sand from drifting across the mouth of the river and forming a bar, and also to enable the currents to scour and maintain a deeper channel in the bar previously formed.

The original project for this work was undertaken in 1866, and in 1873 all the work then contemplated had been completed.

A full history of the improvement to that date is included in the Annual Report of Chief of Engineers for 1874, Appendix Y, page 34.

Under the act of Congress approved August 2, 1882, a survey was made in the summer of 1883, and it being found that the work thus far completed was insufficient for the purpose, a further plan was submitted in the Annual Report for 1884. The project submitted comprised the following:

1. Raising the breakwater to height of 15 feet above low water, making a width of 12 feet on top, and replacing injured parts	$70,0
2. Dredging in channel to 5 feet at mean low water	11,5
3. Extending breakwater to Sharp's Ledge	220,0
4. For stone wing-dam or jetty on south side of channel	55,0
Total	356,5

For this work there was appropriated by act of July 5, 1884, $15,000. Of this amount there has been expended to June 30, 1886, the sum of $14,973.64.

On the 1st of July, 1885, a contract for delivering stone in the breakwater, made October 20, 1884, with Messrs. Hamilton & Soule, of Chebeague, Me., was still incomplete. Work under this contract, commenced in May, 1885, was concluded September 28, 1885. The amount of stone placed in the breakwater during the last fiscal year was 7,280¾ tons, and 216 cubic feet of ashlar on outer end. Under this contract the re-enforcements and repairs to the breakwater were completed for a distance of 510 feet from the outer end, and considerable stone was deposited over an additional distance of 175 feet. Owing to the settling of stone in the sand, as well as partial displacement by the sea, the quantities required to complete the repairs of the breakwater are found to be approximately 25 per cent. more than was originally estimated by figuring on exact dimensions. The average cost under the last contract, including all contingent expenses of engineering, &c., is in excess of $1.41 per ton. The amount still required to complete the first part of the project is therefore amended as follows: 52,000 tons of stone in breakwater, at $1.42 per ton, $73,840. The entire sum could be profitably expended in the next fiscal year.

The cities of Biddeford and Saco, about 5 miles from the mouth of the river, are manufacturing places of considerable importance, and upon the navigation of the river the prosperity of these places largely depends.

It is believed that no good channel can be maintained across the bar until the current can be limited and confined by constructing the jetty opposite the breakwater.

The jetty is at present a much more important factor, in deepening the bar at the mouth, than any other work, and it should be undertaken as soon as practicable.

The deposition of stone in the jetty, or breakwater, is of such a character that the amount which may be profitably done in any fiscal year is only limited by the available funds.

It is recommended that $100,000 be appropriated for the next fiscal year for constructing the jetty and continuing work upon the breakwater.

Only approximate statistics of the commerce of Saco and Biddeford have been received. The deputy collector of customs at Saco estimates that at least 25 per cent. is saved in freights on all articles which come by water, and that large amounts of cotton, coal, and other merchandise now moved by rail would go by water with great advantage were the facilities sufficient.

The statistics appended hereto are furnished from the office of the collector of customs for year ending December 31, 1885.

Money statement.

July 1, 1885, amount available	$10,293 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	10,267 24
July 1, 1886, amount available	26 36
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	12,526 36
Amount (estimated) required for completion of existing project	347,840 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrival of vessels	270
Departures	270

Imports by water.

Coal	tons	40,000
Moulding sand	do	7,000
Cotton	bales	8,750
Pig-iron	tons	4,000
Iron pipe	do	4,000
Paving stones	do	456
Pitch	barrels	150
Gravel	tons	250
Lime	casks	8,000
Cement	barrels	2,500

Ashes	bushels..	3,0
Paper	rolls..	3
Timber	tons..	1
Plaster	do....	1,5
Paints, oil, lead, &c	do....	1

Exports by water.

Stone	tons..	10,0
Ice	do....	10,0
Bricks	number..	2,000,

A 9.

IMPROVEMENT OF SACO RIVER, MAINE.

Under the requirements of the river and harbor act of July 5, 18 a preliminary examination was made, and a report submitted by Col. E. Blunt, dated September 1, 1884. A survey was subsequently m to the towns of Biddeford and Saco, Me., and a report and estimate the improvements considered necessary was made by Col. C. E. Blu dated October 16, 1885.

These reports were printed in House Ex. Doc. No. 37, Forty-ni Congress, first session, and are appended hereto.

Of the amount of $50,000 therein estimated for the improvement the river, $25,000 could be profitably expended in the fiscal year endi June 30, 1888.

COMMERCIAL STATISTICS.

The following statistics of the commerce of the river have been received from collector of the port of Saco, year ending December 31, 1885:

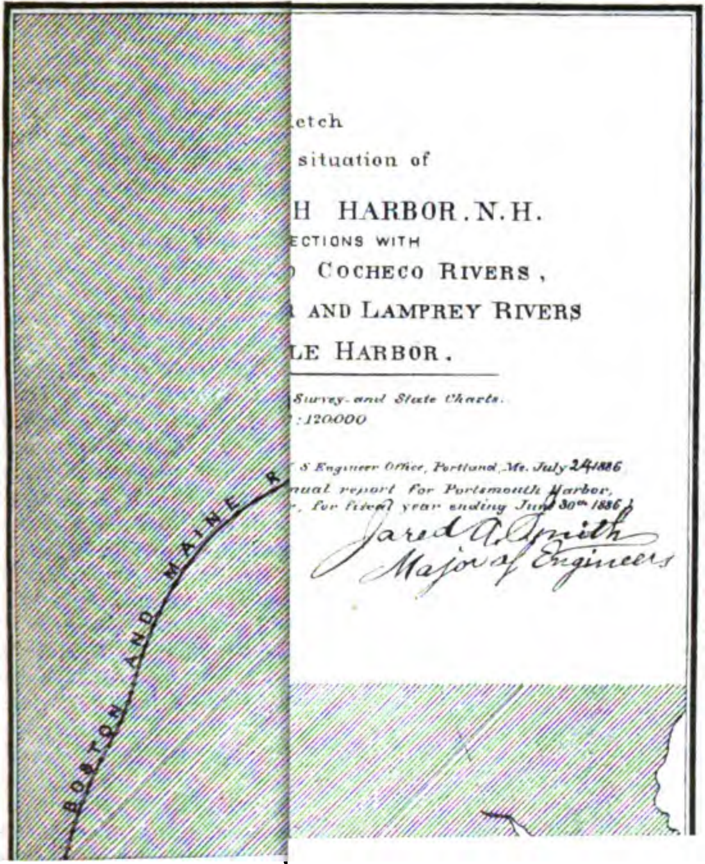
Shipping.	Numb
Arrivals, coastwise	[illegible]
Clearances, coastwise	[illegible]
Foreign	

It is believed that an increased commerce on the water will immediately follow creased facilities therefor.

A 10.

IMPROVEMENT OF PORTSMOUTH HARBOR, NEW HAMPSHIRE.

The harbor of Portsmouth is situated near the mouth of the Piscataq River, on the dividing line between Maine and New Hampshire. Th mean rise and fall of tides is $8\frac{6}{10}$ feet, the extreme variations being, course, considerably greater. A small map accompanies this repo showing the general situation of the harbor and the connecting bays a rivers. A glance at the map will indicate that a large area of water affected by the tides, which must pass and repass through Portsmou Harbor. The currents, therefore, sweep up and down the harbor wi



etch
situation of
H HARBOR.N.H.
ECTIONS WITH
COCHECO RIVERS,
AND LAMPREY RIVERS
LE HARBOR.

Survey and State Charts.
:120000

S Engineer Office, Portland, Me. July 24 1886
nual report for Portsmouth Harbor,
, for fiscal year ending June 30th 1886.

Jared A. Smith
Major of Engineers

eat rapidity. Over much of the distance the channel is comparatively rrow, while the strong currents are diverted from side to side by bends the channel and the projecting ledges which are found on either nd. The difficulties encountered in meeting these strong currents may inferred from the expressive name which is applied to one of the ojecting points of ledge over which the waters rush until the buoy perpetually driven beneath. This is known as "Pull-and-be-damned int," and a similar name might fitly be applied to other angles in the annel.

Within the harbor, and greatly in the way of vessels passing or apoaching the navy-yard, was a ledge known as "Gangway Rocks," havg but 9.7 feet of water at extreme low tides. At times the water ssed over the ledge as over a submerged dam with a force so great at vessels of deep draught could only avoid being forced upon the ck by giving it a wide berth in passing.

When it is remembered that on one side of the harbor is located the nited States navy-yard, and that two fortifications and other works ve been undertaken for its defense, and that more than one-half the ssels arriving pass through the harbor to points on the connecting aters above, it will be seen that the reduction of these difficulties to a inimum is a matter of some importance.

The plan heretofore adopted for remedying the difficulties has been e following:

1st. Constructing a breakwater across the side channel between Great sland and Goat Island. This was completed in 1880, but has since een reinforced by receiving the stone excavated from Gangway Rock.

2d. Removing Gangway Rock to a depth of 20 feet at mean low water. he depth was restricted to 20 feet, owing to the expense attending a reater depth.

3d. Removing to 10 feet at mean low water the ledge on the point of adger's Island.

The entire cost originally estimated was $150,000. From 1879 to 1886 here has been appropriated for the work the sum of $92,000. Of this mount there was expended up to June 30, 1886, $91,991.28.

On the 1st of July, 1885, a contract was outstanding with Mr. George V. Townsend, of Boston, for the removal of 808 cubic yards of Gangay Rock. The work was pushed forward during the summer of 1885 ntil it become necessary to suspend in November. Operations were esumed April 20, and work under the contract was satisfactorily comleted on the 19th of June, 1886. There still remains to be removed the mount of 632 cubic yards to complete the improvement at Gangway ock as projected. Until the entire amount can be removed little or no enefit can be experienced from that which is already accomplished, for he smaller area of ledge, with its edges nearly vertical, is quite as dangerous an obstacle as the larger area with its less abrupt sides.

The estimated expense to complete the removal to a depth of 20 feet s, including engineering, &c., $20,000.

It is believed that a greater depth upon Gangway Rock would be very desirable, as it lies opposite the navy-yard and directly in the way of large vessels, which will necessarily have in future a great draught of water.

In the further removal of rock from the point of Badger's Island, it is believed that it will be found advisable to make the depth of water sufficiently great to insure the unobstructed passage of the largest vessels navigating the river at the lowest stages of the tide.

As it is not likely that funds will be available sufficient to undertake the last-mentioned work for one or more years, no estimate for the increased quantity is here submitted. It is proposed to apply any funds which may become available for improving the harbor, first, to completing the removal of "Gangway Rock." Meantime the proper depth to which it may be desirable to remove the ledge at Badger's Island, and perhaps also at "Pull-and-be-damned Point," may be more fully considered.

The last annual report placed the estimate to complete the project at $30,000. This was based upon the last contract price, which was exceptionally low. The remaining part of "Gangway Rock" is comparatively small in amount and so situated as to be more expensive than heretofore, the average depth to remove being less. It is therefore believed that the original estimate of $30 per cubic yard is more prudent. This would require, including the usual contingencies for engineering, surveys, &c., $40,000 to complete the project.

Portsmouth is a port of entry. The light-houses are the harbor light at Fort Constitution and Whale's Back at the entrance.

The defenses of the harbor are all incomplete works: Fort Constitution and an open battery on the west side, and Fort McClary and an open battery on the east side

Money statement.

July 1, 1885, amount available	$15,211 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	15,202 28
July 1, 1886, amount available	8 72
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,008 72
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following information has been received from the collector of customs for Portsmouth:

Shipping.	Number.	Tonnage.
Foreign:		
Arrivals	57	6,202
Clearances	54	6,129
Coastwise arrivals and clearances	760	20,865
Amount of revenue collected		$1,200 35
Value of importations		26,420 11

A II.

IMPROVEMENT OF COCHECO RIVER, NEW HAMPSHIRE.

A reference to the map accompanying annual reports for Portsmouth Harbor and Cocheco River will indicate the situation of this river and its connections with other navigable waters.

The Cocheco is a branch of the Piscataqua, which reaches the ocean through the harbor of Portsmouth, N. H. At Dover, N. H., a fall in the river limits navigation to that point where the mean rise and fall of the tides is 6¾ feet.

The river below Dover is really a part of the tidal arm of the sea. Its entire length subject to tides is approximately 3 miles, its mouth being about 13 miles from the Atlantic Ocean by way of the Piscataqua River.

From Dover to the lower narrows, a distance of about 1½ miles, the river was originally much obstructed by bowlders, ledges, and shoals.

In 1870 an examination of the river was made and certain plans, since adopted and carried out as the necessity arose, have so far increased the commerce of the river that the present facilities are insufficient for its accommodation. In a recent examination of the river, passing from Dover to Portsmouth on a tug, I observed six heavily laden schooners, estimated at from 200 to 400 tons each, all awaiting a favorable tide to proceed up the river to Dover.

The following appropriations were made for improvement of the Cocheco River, up to 1878:

July 4, 1836	$5,000
March 3, 1837	5,000
March 3, 1871	10,000
June 10, 1872	10,000
March 3, 1873	10,000
June 23, 1874	10,000
March 3, 1875	25,000
August 14, 1876	14,000
June 18, 1878	6,000
Total	95,000

All the improvements which had been previously contemplated were completed in November, 1878.

The new facilities thus afforded attracted a great number of vessels of large size, to replace the flat-boats and scows which had been previously employed.

The urgent need of further improvements was so represented by the Board of Trade that, by the act of August 2, 1882, Congress appropriated $28,000 for the purpose. This was applied to making a cut-off channel through Alley's Point; and widening to 60 feet, and deepening to 5 feet, the channel through Trickey's and Clement's Point shoals. This work was essentially completed in November, 1883.

The act of July 5, 1884, appropriated $28,000 for completing the improvement. Referring to this appropriation, the last Annual Report states:

> As soon as possible after it became available a careful examination, including borings, was made of the upper channel. The new estimate based thereon proved that the necessary improvement could not be executed with the available funds.

An additional estimate of $19,000, to complete the project, was therefore submitted.

On the 1st of July, 1885, a contract was outstanding with Thomas Symonds, of Leominster, Mass., for removing hard pan, bowlders, and rock. Work under the contract was completed September 9, 1885. The amount of solid rock removed after July 1, being 829 cubic yards. This completes the channel to near the Steam-mill Wharf to a depth of 5 feet, and a width varying from 50 feet to 60 feet. While a draught of 5 feet at mean low water is of vast benefit to the place, and has made the channel navigable nearly to Dover for vessels of 600 tons, or even more, at extreme high water, yet the *time* for such navigation is limited to very short intervals near the highest stages.

The bridge across the Piscataqua river near Portmouth Harbor has draw very narrow and badly arranged, so that it is generally a very convenient, slow, and tedious process to pass vessels through. In pa ing through the draw with the tide it is, in general, necessary to mo the vessel and allow it to drop through the narrow space stern fo most, requiring great pains to accomplish it without injury. Althou not on the Cocheco River, the bridge is so intimately related to th branch that it is here mentioned as one of the serious obstructions that navigation.

Vessels of the largest draught now have to be lightered a short d tance in order to reach the wharves in the city of Dover.

I am informed by a committee of the Board of Trade that Dover becoming a city of extensive manufactures—it is already larger th Portsmouth in population and assessed valuation; that in the last y nearly one hundred vessels arrived at its wharves; that cargoes of co or other heavy freights arriving in vessels, have to be in part lighter to the wharves at an expense of 35 cents per ton; that two vessels ha arrived with cotton from the South; and that it would be greatly to th interest of the extensive cotton and woolen mills to obtain all their ra materials by water, were the facilities sufficient to enable them to do that, owing to the expense of delays and lightering, a considerable p of the coal and other heavy freights now arrives by rail at an increa expense over rates by water with a good channel; that, owing to th facilities already created, new vessels are being yearly built for th traffic.

The following extract from Report No. 1994, House of Representativ Forty-ninth Congress, first session, gives so complete a statement of th business interests involved that it is quoted in this connection:

> The city of Dover is situated at the head of tide-water and navigation on the Coch River. It is the largest and most important place between Haverhill on the sou Portland on the northeast, and Manchester on the northwest. It is the county s of the county of Strafford, and contains the various county buildings and the cou offices.
>
> The population of the city is now nearly 15,000, and the valuation for taxable p poses is between $10,000,000 and $11,000,000, exclusive of the public property. T city has public property in real estate of the value of $250,000.
>
> The Cocheco River is navigable for vessels of 600 tons burden and drawing 10 to feet of water, and a large commerce is carried on in coal, grain, lime, cement, other heavy merchandise. There are 100 arrivals per annum, at the wharves, of v sels from the British provinces and all along the Atlantic coast. When the proje improvements of the channel are completed there can be no doubt the river busi will be of such dimensions as to require custom-house accommodations.
>
> In postal rank and business the city ranks as second in the State.
>
> The Cocheco Manufacturing Company has a capital of $1,500,000. It has five mil from five to seven stories high, engaged in the manufacture of cotton cloths, of whi it turns out 32,000,000 yards per annum. It is connected with the Cocheco Pri Works, which prints 40,000,000 yards per annum. Together they use 12,000 bales cotton per annum, employ 2,000 hands, and have a monthly pay-roll of $50,000.
>
> The Sawyer Woolen Mills consume 2,600,000 pounds of wool each year, employ to 500 hands, and produce goods annually of the value of $1,200,000.
>
> The shoe manufacturing industry of the city is larger than in any other city of th State, employing 1,300 hands, with a monthly pay-roll of some $40,000.
>
> There are also numerous small industries of great importance and magnitude in th aggregate.

The interests involved indicate the necessity of increasing the wid and depth of the channel at least to such an extent that any ves which may pass over the Piscataqua River to the Cocheco may co tinue on to Dover without obstruction or necessity for lightering. On foot added to the depth of the channel adds two hours for each tide e time in which a vessel of any draught greater than 5 feet may be ken up or down the river.

The improvement required to complete the present project is to deepen e channel from Collins' Steam mill Wharf to the Packet Landing, so as give a depth of 5 feet at mean low water.

The widths of the channel cuts are, in general, about 60 feet, though places they are but 50 feet. While these widths form a navigable annel, they are not sufficient to permit vessels of any size to pass ch other safely, nor to permit of convenient handling.

The total amount appropriated from 1836 to 1886 has been $151,000. f this amount there was expended previous to June 30, 1886, $150,973.64.

It is believed that in future it will be found necessary to increase the pth of channel and to make the widths of cuts as great as 75 feet. No timate for this work is, however, here submitted, as it is considered tter to complete the work heretofore outlined before undertaking new ojects. (See map with last Annual Report.)

Portsmouth is the nearest port of entry to the city of Dover.

Money statement.

ly 1, 1885, amount available	$9,804 41
ly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,792 29
ly 1, 1886, amount available	12 12
mount appropriated by act approved August 5, 1886	10,000 00
mount available for fiscal year ending June 30, 1887	10,012 12
Amount (estimated) required for completion of existing project	9,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	9,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following commercial statistics for the city of Dover have been received:

umber of vessels arrived and cleared		100
oal received by water	tons	25,000
oal received by rail	do	7,700
ime, &c., received by water	casks	12,000
umber received by water	feet	2,500,000
hingles received by water		8,000,000
lapboards received by water		750,000

The other articles received and shipped in the last year, for which water transortation would have been largely used with a good channel, are the following:

otton	tons	3,100	Leather and hides	tons	3,050
hite cloth	do	1,000	Grain	do	3,575
ool	do	1,300	Flour	do	1,550
roceries	do	5,100	Iron and hardware	do	1,582
eats	do	1,250	Paints, &c	do	450
erosene	do	650	Salt, coarse	do	350
ils	do	120	Machinery	do	300
tarch	do	110	Marble	do	100
ertilizers	do	75	Prints	do	3,300
oots and shoes	do	2,100	Woolens	do	600
elting	do	400	Iron manufactures	do	150
iscellaneous	do	1,500			

A 12.

PRELIMINARY EXAMINATION OF SACO RIVER, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., September 1, 1884.

GENERAL: The act of Congress approved July 5, 1884, for the i provement of rivers and harbors, &c., provided for a survey of Sa River, Maine, and the preliminary examination required by the la having been assigned to me, I have the honor to submit the followi report:

Expenditures have already been made at this locality by the Unit States for piers at various points of the channel and a breakwater the mouth. Certain sunken rocks and ledges have also been remove

A survey at the entrance of the river, including the breakwater, wa made in 1883, having been provided for in the river and harbor a passed August 2, 1882. A project and estimate based upon this surv were made and submitted to Congress January 8, 1884. (See Senat Ex. Doc. No. 44, Forty-eighth Congress, first session.) An appropri tion of $15,000, for improving the breakwater, was made by the riv and harbor act approved July 5, 1884.

This survey developed the fact that dredging was required at th mouth of the river, and estimate therefor was made. Although it wa then known that improvement above the mouth was desired, no surve or estimate was then made therefor, as it could not be properly do under the law. Undoubtedly the survey now called for is intended t cover the upper part of the river.

Mr. Carl Berrer, draughtsman and acting assistant engineer, has examined the river under my instructions and obtained from sundry parties their views of what is wanted. Mr. Berrer's report is submitte herewith. I also transmit a copy of a tabular statement handed me b Mr. Thomas Quinby, of Biddeford, giving certain commercial and manufacturing statistics.

Saco and Biddeford (the latter an important manufacturing town) li at the head of navigation of the Saco River. I consider the riv worthy of additional improvement in the interest of the business o these towns, and respectfully recommend that a survey be made as basis for a project and estimates for the improvement desired. Th survey will probably cost $200.

The drawing referred to by Mr. Berrer is transmitted to-day in a separate roll.

Respectfully submitted.

CHAS. E. BLUNT,
Colonel of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

REPORT OF MR. CARL BERRER, ACTING ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., August 15, 1884.

COLONEL: I have the honor to submit the following report upon the preliminar examination of Saco River, Maine, made August 11, in pursuance to your instructio

The head of tide-water of Saco River is at the adjoining towns of Saco and Biddeford, and the improvements asked for are below these places.

From the entrance to Saco River, near the shore-end of Saco River Breakwater, up to the wharves at Saco and Biddeford, there is a channel of 6 feet depth at mean low water, or about 14½ feet at mean high water, and of sufficient width, except at the following places, marked with corresponding letters on the accompanying sketch.

At "a" the 6-foot channel is closed by a sand bar of a length of about 500 feet, with a depth of only 4 feet at mean low water.

At "b" (between Little Islands) the channel, which is very narrow at this place, is obstructed by a ledge in mid-channel with less than 4 feet at mean low water on its shoalest point; between "c" and "d" (from the head of Thunder Island to the foot of Cow Island) the channel for a distance of about 1,800 feet is irregular, with a least depth of 4½ feet at mean low water; between "e" and "f" (at the head of Cow Island) the channel is narrow, and has a least depth of only 3½ feet at mean low water; at "g," below the principal wharves, a part of the shoal, consisting of sand and sawdust, is desired to be removed, so as to give a width of 200 feet, in order to allow vessels to turn.

A depth of not less than 6 feet at mean low water is to be obtained over all the above-named shoal places.

To insure the permanency of the channel at the head and north of Cow Island the channel south of this island might be advantageously closed by a dam, as shown at "h."

The pier (No. 2) at the head of Thunder Island needs repairing, and its top should be raised above extreme high water.

The principal imports are coal and cotton. Full statistics will be furnished by Mr. Thomas Quinby, agent of Pepperell Manufacturing Company, the largest cotton-mill at Biddeford.

The places where improvements are desired were pointed out to me by steamer and tow-boat captains.

Very respectfully, your obedient servant,

CARL BERRER.

Col. C. E. BLUNT,
Corps of Engineers, U. S. A.

RIVER COMMERCE OF SACO AND BIDDEFORD, MAINE, FOR THE SEASON OF 1883 (APRIL 15 TO DECEMBER 1).

[Received from Mr. Thomas Quinby, agent of Saco Water Power Company, August 30, 1884.]

The following articles were received by sundry manufacturing companies and other consignees during the season:

Articles.	Quantity.	Articles.	Quantity.
Coal .... tons..	33, 813	Gravel .... tons..	216
Sand .... do....	691	Lime .... casks..	8, 000
Cotton .... bales..	8, 750	Cement .... do....	2, 500
Iron .... tons..	2, 466	Plaster .... tons..	1, 500
Paving .... do....	456	Ashes .... bushels..	3, 000
Pitch .... barrels..	108	Timber .... tons..	102
Paper .... rolls..	300	Ice .... do....	6, 000

Mr. Qninby also gives the names of forty or fifty schooners engaged in the trade, and states that there are quite a number of others.

SURVEY OF SACO RIVER, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., October 16, 1885.

SIR: I have the honor to submit herewith report of the survey of Saco River, Maine, made under instructions of the Department and in compliance with the act of Congress approved July 5, 1884, for the improvement of rivers and harbors, &c., it being accompanied by a tracing*

---

*Omitted.

(sent separately by to-day's mail) on a large scale, showing the results of the work, and indicating the improvement suggested; a small sketch* of the river is also sent. It can advantageously be printed with the report. Mr. C. Berrer, acting assistant engineer, has executed the work under my direction. His report to me, which is approved, is submitted herewith as part of my own. The shoal ground at the river entrance is not included in the estimate now given, as that was made and submitted with my report relating to the repairs of the breakwater in 1883.

With regard to the importance of the improvements now proposed in comparison with that on the breakwater, which has already been begun, I am constrained to say that it seems to me that the latter should take precedence. I do not think that it would be advisable to make two separate appropriations for this river or divide the expenditure of one into two parts. Any sum likely to be appropriated next session for the Saco River should, in my judgment, be expended exclusively for the breakwater.

I accordingly do not recommend the appropriation or expenditure of any money for next year for the improvements suggested in this report. (My annual report for the breakwater asks for $50,000 for the continuation of that work.)

I have not succeeded in obtaining any special statistics of the commerce of Saco and Biddeford. They are important manufacturing towns, but a large proportion of all goods needed there have come, and will continue to come, by railroad entirely, irrespective of any river improvements.

Respectfully submitted.

C. E. BLUNT,
Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. CARL BERRER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., October 15, 1885.

COLONEL: I have the honor to submit the following report upon the survey of Saco River, Maine, made in pursuance of verbal orders received from you:

The field work was commenced December 16, 1884, but had to be suspended December 18, on account of ice; it was again commenced May 27, and completed June 18, 1885. The result of the survey is embodied in the maps (scale 1 : 2,000), also herewith submitted, together with a sketch of the navigable part of the river (scale 1 : 15,000).

The soundings, numbering 6,300, were taken on ranges established on shore, each sounding being located by a transit angle from a fixed line. The triangulation stations were marked, where possible, by holes drilled in ledges. The soundings are referred to a plane of mean low water, determined by tide observations taken during the survey, but I was told that at the time the river was above its usual summer level.

Two permanent bench-marks (positions shown on map) were established, 8.917 feet and 6.40 feet, respectively, above the plane of low water of this survey. The character of the material forming the several shoals to be excavated was ascertained in many places. It consists, at or near Little Islands, of sand and gravel, rocks and some logs; above pier 2, of sand and gravel, slabs, logs, and sawdust.

Saco River is navigable for a distance of 5 miles from its mouth to the adjoining towns of Saco and Biddeford, at the head of tide-water.

A continuous channel with not less than 6 feet of water at mean low tide is asked for. At present the only serious obstructions in the channel are at and near Little Islands and from the head of Thunder Island to the town wharves. The survey was, therefore, confined to those two localities.

---

* Omitted; printed in House Ex. Doc. No. 37, Forty-ninth Congress, first session.

The shoals at the mouth of the river are to be removed by the work now in progress there. (See report on Saco Breakwater, 1883.)

From the shore end of the breakwater the channel is of good width and of not less than 6 feet depth at mean low water up to Chandler's Point; a bar with 4½ feet obstructs the channel from this point to Little Islands. Between the Little Islands a ledge with only 2.9 feet at mean low water over its shoalest point greatly endangers navigation. Above this place the channel is narrow, and needs widening and straightening. The river here is very wide, and in order to confine the current and keep the dredged channel open a submerged jetty (A) of the following dimensions—height above mean low water 3 feet; width on top 3 feet—with slide slopes of 45 degrees, built of rubble-stone—is projected from Little Islands to the north shore.

From Johnston's Wharf to the head of Thunder Island the 6-foot channel is continuous, and of sufficient width, except in a place marked C on sketch, where an obstruction (probably a portion of pier 2) in mid-channel should be removed.

Above the head of Thunder Island the river widens considerably, the 6-foot curve ends, and continuous dredging is required up to the brick-yard. Material, sand and gravel.

At Cow Island the channel is crooked and of insufficient depth, and has to be straightened and deepened. Above Cow Island a part of the large shoal (dry at half tide) is proposed to be removed, to enable vessels to come up to the wharves.

The narrow, crooked channel south of Cow Island, which is of no practical use, is proposed to be closed by a submerged jetty (B), built of rubble-stone; dimensions: height, 5 feet above low water; width on top, 5 feet, with side slopes of 45 degrees.

The large shoal off the wharves in mid-river, consisting of sand and gravel, slabs and edgings, and logs and sawdust, has existed for a long time, and has not materially changed in late years; it was created before the dam between Saco and Factory Island was constructed. The river, rising back in the White Mountains, during spring freshets carried large quantities of sand, and more particularly logs, sawdust, and other refuse, from the saw-mills above with it. The currents of the two branches of the river, meeting just below Factory Island, created strong eddies, whereby the material was deposited. Since said dam was built comparatively little water comes down this (north) branch of the river, the main body of water going through the southerly branch with a strong current. There is also, lately, much less mill refuse thrown into the river than formerly. It is therefore believed that, with the aid of the submerged jetty (B), the improvement projected at this place will be permanent.

Ten piers were built at different times between Saco and the mouth of the river. Their object was to prevent (sailing) vessels from striking the dangerous rocky points upon which they were erected. Four of these piers (Nos. 2, 7, 8, and 9, rebuilt in 1873 and 1874) are now in existence; the others have disappeared and need not be replaced. All merchant vessels now make use of tow-boats in ascending and descending the river, and therefore have less difficulty in keeping clear of the projecting ledge points.

Pier No. 2, at the head of Thunder Island, is considerable damaged by ice and by vessels running against it; its top is covered at high water, and as almost all navigation is carried on at or near high water, it is, in its present condition, of no benefit and is even dangerous. If the channel above be dredged as projected, there will be no difficulty in avoiding the ledge point which it marks, and its entire removal is recommended. Pier No. 7 is in good condition. Pier No. 8, at Ferry Narrows, through which the current runs very strong, is built over a dangerous ledge and should be preserved. It needs new oak planking at its lower end, also new cap and cross timbers. Pier No. 9, at Jordan's Point, does not require any repairs at present.

ESTIMATE.

Dredging above and below Little Islands, 16,160 cubic yards, at 40 cents per cubic yard *in situ*	$6,464
Ledge excavations at Little Island, 214 cubic yards, at $20 per cubic yard	4,280
Submerged jetty A, 2,500 tons of rubble-stone, at $2	2,500
Dredging between pier 2 and wharves, 110,000 cubic yards, at 25 cents per cubic yard *in situ*	27,500
Submerged jetty B, 2,200 tons of rubble-stone, at $1	2,200
Repair and removal of piers, incidentals, contingencies, &c	7,056
Total	50,000

Very respectfully, your obedient servant,

CARL BERRER,
Acting Assistant Engineer.

Col. C. E. BLUNT,
Corps of Engineers, U. S. A.

APPENDIX B.

IMPROVEMENT OF HARBORS AND RIVERS IN MASSACHUSETTS.

REPORT OF MAJOR GEORGE L. GILLESPIE, CORPS OF ENGINEERS, BVT. LT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Newburyport Harbor, Massachusetts.
2. Merrimac River, Massachusetts.
3. Scituate Harbor, Massachusetts.
4. Boston Harbor, Massachusetts.
5. Plymouth Harbor, Massachusetts.
6. Provincetown Harbor, Massachusetts.
7. Lynn Harbor, Massachusetts.
8. Malden River, Massachusetts.
9. Harbor of Refuge at Sandy Bay, Cape Ann, Massachusetts.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., July 24, 1886.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1886, of the improvement of rivers and harbors which are in my charge.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Major of Engineers,
Bvt. Lt. Col., U. S. A.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

B 1.

IMPROVEMENT OF NEWBURYPORT HARBOR, MASSACHUSETTS.

I relieved Maj. C. W. Raymond, Corps of Engineers, of the charge of this work, February 4th, 1886, in accordance with Special Orders No. 16, Adjutant-General's Office, dated January 20, 1886.

The object of this improvement is to create at the outer bar a permanent channel 1,000 feet wide at its entrance, with a least depth of 17 feet at mean low water, or 24½ feet at mean high water, so that vessels of as large draught as can reach Newburyport, may enter the river. Previous to the commencement of the work there was on the bar a depth of about 7 feet at mean low water.

The project is to build out from the shores north and south of the harbor outlet, two converging rubble-stone jetties so located as to give proper direction to the channel, and by scour of the resulting currents to produce and maintain the desired depth. The location of these jetties is shown on the map in the Report of the Chief of Engineers for the year 1884. Their form and dimensions are shown on the map in the report for 1881. The channel at the eastern entrance will be 1,000 feet wide and will be embraced by parallel sections of the two jetties, each 1,000 feet long. The project also contemplates the protection of th shores in the vicinity of the jetties, if necessary, and the constructi of a dike across the basin of Plum Island, to prevent the opening of new channel, should the outer beach be broken through. The locati and details of construction of the dike are shown on the map in th Report of the Chief of Engineers for the year 1883.

The cost of this improvement was originally estimated to be $365,00 This, however, did not include the cost of the dike, the construction which was not contemplated when the original estimate was made The dike was estimated to cost $10,000, making the total estimate $375,000.

For this improvement the following appropriations have been mad by Congress:

By the river and harbor act of June 14, 1880	$50,0
By the river and harbor act of March 3, 1881	40,0
By the river and harbor act of August 2, 1882	40,0
By the river and harbor act of July 5, 1884	40,0
Total	170,0

The amount expended to June 30, 1885, was $160,131.86.

The condition of the work June 30, 1885, was as follows:

Work under the following contracts was in progress:

1. With Mr. C. H. Edwards, of Boston, Mass., contract dated September, 17, 1884, to deliver in the north and south jetties 17,000 tons more or less, of rubble stone. There had been delivered, under thi contract, $16,820\frac{1288}{2000}$ tons.

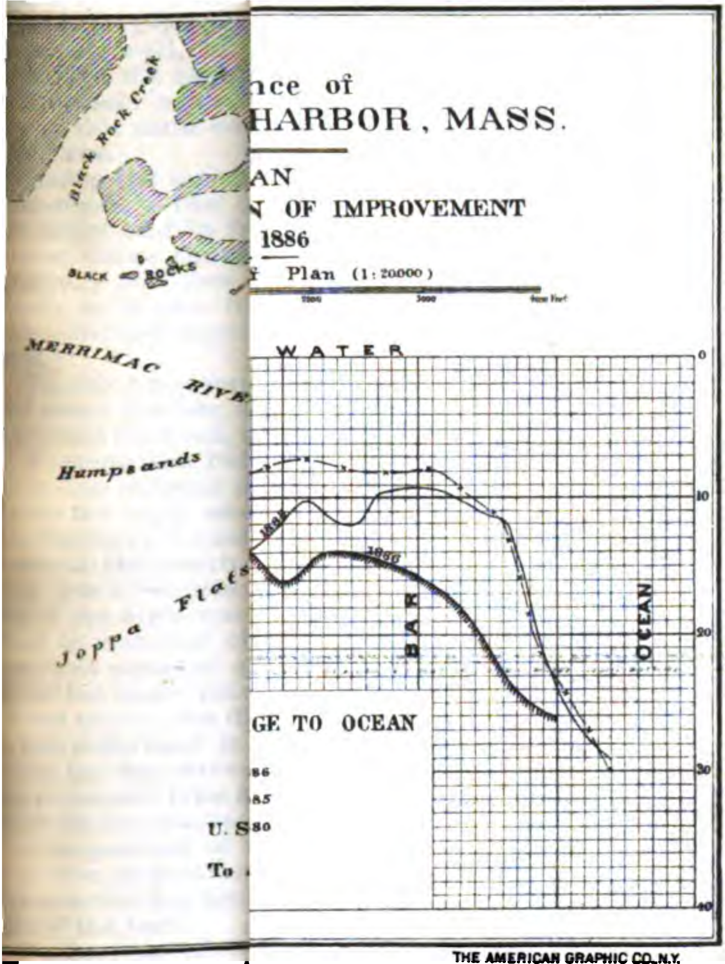
2. With Mr. G. W. Townsend, of Boston, Mass., a contract date September 17, 1884, for removing three sunken ledges in the harbo channels. One ledge had been partly removed.

The Plum Island dike had been completed as far as was at that tim prudent. A central opening, 300 feet wide and 2 feet deep at mean lo water, was still unclosed. No work has been done on this dike durin the year, and none is expected to be necessary during the coming year The work remains in good order, and large quantities of sand are r tained in the basin.

Mr. Townsend completed his contract in September, 1885; 52 cubi yards of stone were removed from the three ledges, over which ther is now 9 feet at mean low water.

Mr. Edwards completed his contract in August, 1885, having delivered, during the fiscal year, 1,872.720 tons, or a total, under his contract, of 18,692.1920 tons, of which 17,656.360 tons were placed in the north jetty, and the balance in the south jetty.

The north jetty was 2,640 feet long; of this, 1,540 feet was completed; the remainder was a core, raised approximately to the plain of mea low water. During the year this core was extended 35 feet, and "levelled up" over its whole length. The jetty is now 2,675 feet long, 1,54 feet of full section and the balance a core, all in good order.



THE AMERICAN GRAPHIC CO., N.Y.

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Money statement.

July 1, 1885, amount available..
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885..

July 1, 1886, amount available..

Amount (estimated) required for completion of existing project.........
Amount that can be profitably expended in fiscal year ending June 30, 1888
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

B 3.

IMPROVEMENT OF SCITUATE HARBOR, MASSACHUSETTS

I relieved Maj. C. W. Raymond, Corps of Engineers, U. the charge of this work, February 4, 1886, in accordance with Orders No. 16, Adjutant-General's Office, dated January 20, 18

The object of this improvement is to create a harbor of re vessels when eastward of Boston.

At the commencement of the improvement the harbor ha water area of about 57 acres, over 6 acres of which there was of at least 3 feet at mean low water. It was open to the actio erly winds.

The project adopted in 1880 is to build two breakwaters; (o "Cedar Point," on the north side of the entrance, and the ot the point of the "First cliff" on the south side); and to de area inclosed and in front of the entrance by dredging.

The breakwaters are to be of rubble-stone and are to be 20 f on top, which is in a plane 4 feet above mean high water, e the outer ends, which are raised 6 feet higher, so as to be cons guides for entrance.

The dredging proposed (covering a channel length of 2,700 f require the removal of 500,000 cubic yards, and will give a dep feet at mean low water in the entrance channels; from 12 to 15 tween the breakwaters; 12 feet immediately in rear of the south water, and 10 feet for the main harbor basin.

The estimated cost of the breakwaters was $100,000, and of the ing $190,000, or a total of $290,000 for this improvement.

In aid of this project the following appropriations have bee by Congress, viz:

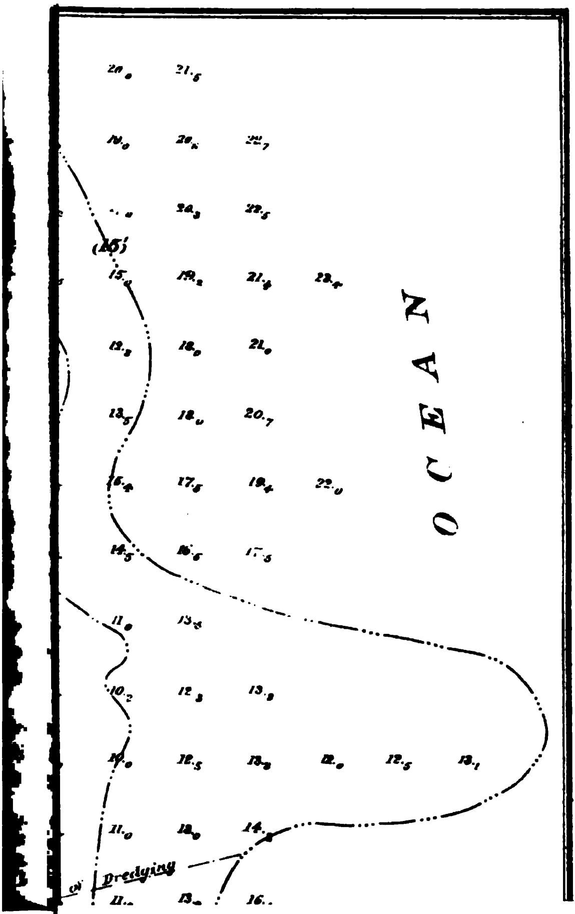
By the river and harbor act of June 14, 1880..........................
By the river and harbor act of March 3, 1881..........................
By the river and harbor act of August 2, 1882..........................
By the river and harbor act of July 5, 1884..........................

Total..

The total amount expended to June 30, 1885, was $37,108.54.

The condition of the improvement June 30, 1885, was as follo

The north breakwater had been constructed to its full heig length of 720 feet, about 15,000 tons of rubble-stone having bee place. The south breakwater had not been commenced. A po the beach between Cedar Point and the land had been protect



OCEAN
Dredging
(15)

rush and stone bulkhead 45 feet long, in front of which was a stone pron 10 feet wide and 385 feet long.

For temporary relief to commerce, a channel 1,600 feet long, 100 feet ide, and 5 feet deep at mean low water, starting at a point 300 feet ast of the north end of the proposed south breakwater, had been cut s far westward as the "Deep Hole," where an inner basin had been repared, 200 feet by 160 feet, with 7 feet depth at mean low water.

No work of improvement was done during the year, but a survey was ade the latter part of June, 1886, which shows that the dredged channel and basin have not materially changed since the completion of the ork in June, 1885. The 5-foot channel is generally more than 100 feet ide, although at a point opposite the proposed south breakwater it is r a length of 150 feet only 50 feet wide, of the full depth (5 feet). The emainder of the width is about half a foot shoaler.

The balance on hand July 1, 1886, is $165.60, not sufficient to continue he improvement. It will be applied to inspecting the condition of the nprovement from time to time.

"Harbor Rocks" should be removed. They form an obstruction arked by a buoy, about 500 feet east by south from the outer end of he south breakwater, and near the southern edge of the dredged hannel.

They consist of several detached rocks, covering an area of about 50 eet square; they project about 1½ feet above mean low water, and to educe them to the plane of the bed of the sea in the vicinity will require the removal of 108 tons of stone, estimated to cost $648.

To complete the project will require an appropriation of $252,500, of hich amount $100,000 could be profitably expended during the fiscal ear ending June 30, 1888. This sum, if appropriated, it is proposed to xpend in continuing the approved project as follows:

uild south breakwater, 20,000 tons, at $2.15	$43,000
emove harbor rocks, 108 tons, at $6	648
nlarge basin to eight acres, 10 feet deep, and channel to 150 feet wide and 10 feet deep, at mean low water, 160,000 yards, at 30 cents	48,000
ontingencies	8,352
	100,000

This work is located in the collection district of Plymouth, Mass. The nearest port f entry is Plymouth, Mass. The nearest light-house is Minot's Ledge Light, distant bout 5 miles.

The accompanying commercial statistics for the fiscal year ending une 30, 1886, have been furnished by the collector of customs at Plymouth, Mass.

Money statement.

uly 1, 1885, amount available	$391 46
uly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	225 86
uly 1, 1886, amount available	165 60
mount appropriated by act approved August 5, 1886	10,000 00
mount available for fiscal year ending June 30, 1887	10,165 60
Amount (estimated) required for completion of existing project	242,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, PLYMOUTH, MASS.,
Collector's Office, June 25, 1886.

SIR: I answer to your request for "detailed" information for "Scituate Harb I answer that personally I have but little knowledge of it, as it is some 25 miles d tant from this port, but from information gathered from deputies and others I enabled to present the following report:

There is belonging to the port 4 vessels, ranging from 6 to 10 tons burden, that engaged in mossing and fishing, producing annually about $35,000 worth of Ir moss (as it is called), and $4,000 worth of fish.

There is landed annually about 12 cargoes of lumber and 10 of coal, and about sail of small size vessels, such as yachts, &c., harbor there in the course of the sea

The channel dredged by Government does not fill up, and the Government w stood well the heavy storms of the last winter.

There is no manufacturing interests of consequence at the port, the business be mostly agricultural. Its value as a harbor of refuge is quite uncertain, but shou ship in distress within the bay be so fortunate as to enter the harbor, the saving life and property in this one instance would far outweigh all the costs of constructi

We do not feel competent to (as asked) offer any suggestions for future impro ments, knowing that engineering skill and practical knowledge far outweigh theori

Very respectfully, your obedient servant,

SAMUEL H. DOTEN,
Collector of Custom

G. L. GILLESPIE,
Major of Engineers, Bvt. Lieut. Col., U. S. A.

B 4.

IMPROVEMENT OF BOSTON HARBOR, MASSACHUSETTS.

I relieved Maj. C. W. Raymond, Corps of Engineers, of the char of this work February 4, 1886, in accordance with Special Orders N 16, Adjutant-General's Office, dated January 20, 1886.

The object of this improvement is, first, to preseve the harbor protecting the islands and headlands, and, second, to improve it widening, straightening, and deepening the channels.

The projects adopted for this purpose since 1866 have been main in accordance with the recommendations of the United States commi sioners, whose labors terminated during that year.

The works of preservation consist of sea-walls, aprons, jetties, &c which protect the shores of the islands and headlands, prevent add tional wash into the channels, control the tidal scour, and preserve t full height of anchorage shelter for vessels in the roadsteads.

The works of improvement have been by dredging and blasting, which means many dangerous rocks and shoals have been removed.

The following sums have been appropriated by Congress for this im provement since 1866:

By acts from March 2, 1867, to March 3, 1879	$1,331,
By act of June 14, 1880 ($30,000 to be expended in Boston Harbor; $22,500 at the mouth of Charles River, in said harbor, and up to Watertown; $17,500 at the mouth of the Mystic River, in said harbor, and $5,000 from said harbor to Nantasket Beach)	75,
By act of March 3, 1881 ($40,000 to be expended in said harbor; $35,000 at the mouth of Charles River, in said harbor, and up to Watertown; $20,000 in said harbor, at mouth of Mystic River, and $5,000 from said harbor to Nantasket Beach)	100,
By act passed August 2, 1882, for completing improvement	96,5
By act of July 5, 1884	5,
Total	1,607,5

The total amount expended to June 30, 1885, was $1,598,971.01.

WORKS OF PRESERVATION.

The condition of the works of preservation on June 30, 1885, was as llows, viz:

Point Allerton.—This point, at the southeast entrance of the harbor, is protected by a granite sea-wall 1,202 feet in length. It was com- eted in 1873. Its concrete foundation, for a distance of 1,005 feet, is protected by an apron and eight jetties of granite rubble-stone. e work was generally in good order. Some of the joints required re- inting. During the year no work has been done on this wall. In vember and December, 1885, and in January, 1886, severe storms t the bluff and beach to the west of the wall. To more fully protect is part of the bluff the wall should be extended to the westward ont 150 feet; this is estimated to cost, with proper riprap aproning its west end, $15,000. The beach further west, along Stony Beach, legraph Hill, and Wind-Mill Point, shows signs of abrasion, but no mediate danger to the channel is anticipated from this wear.

Great Brewster Island.—This island, on the north side of the en- ance to the main ship-channel, was protected by a granite sea-wall 840 feet in length, which was completed in 1869. It was in fair order. me stones, at the southeast angle of the wall, were loose and re- ired resetting, and about 300 feet of the coping course required re- tting; these repairs were estimated to cost $3,000. During the year, o work was done on the wall, and it now remains in essentially the me condition as on July 1, 1885.

George's Island was protected by a granite sea-wall, with rip-rap ex- nsions at the south and west ends.

The sea-wall is 2,150 feet long, and it and the southern rip-rap, 600 et long, were completed about 1835. The western rip-rap, which is 50 feet long, was built in 1884–'85. The sea-wall and ripraps were in ood order on June 30, 1885. No work was done on them during the ear. During the winter of 1885–'86 the unprotected western shore-line f this island, in front of the Government buildings, was considerably braded; the high-water line was moved back, in places nearly 20 feet. his shore-line, 1,400 feet long, should be protected by a light sea-wall, hich is estimated to cost $35,000. Some minor repairs are needed to he sea-wall; these are estimated to cost $100.

Lovell's Island.—The western shore of this island was protected by a bble-stone apron, built in 1873, repaired and extended in 1884. It is 75 feet long. The northern shore was covered by a granite sea-wall, uilt in 1843, and repaired in 1878. It is 750 feet long. The eastern hore was protected by a granite sea-wall, 800 feet in length, completed n 1869; and by rubble-stone aprons between the northern and eastern ea-wall, 1,440 feet long, and south of the east sea-wall one 1,330 feet ng. Those walls and aprons were in good order June 30, 1885. No ork was done on them during the fiscal year. The storms of the winter f 1865–'66 caused the southern part of the western riprap to settle and nove seaward slightly. It is, however, now as efficient a protection as ver, and requires no immediate repair. The north sea-wall and both of he eastern ripraps are in good order.

The eastern sea-wall was considerably injured; about 200 feet of the oping stones on its north end and the cobble-stone paving in rear of his portion of the wall were displaced and thrown, some in front and ome in rear of the wall. This part of the wall requires additional relief o conform to the main part of the wall. These repairs are estimated o cost, including contingencies, $6,000. The southern shore of the island has suffered some considerable abrasion, but no repair is recommended at present, as the study of the survey of this part of the harb has not yet been completed.

Gallop's Island.—The western, northern, and eastern shores of thi island at the close of 1871 had been protected by a granite sea-wa 1,785½ feet long, and by an apron (covering also the foundation of th sea-wall) 3,050 feet long. Both the sea-wall and apron were in goo order June 30, 1885. No work was done on them during the fiscal yea To more completely protect the northwestern bluff of this island the sea wall should be extended about 150 feet to the southward. This, it i estimated, will cost $7,500. The present sea-wall and riprap shore protection are in good order.

Deer Island.—The three prominent heads of this island had been protected by granite sea-walls originally built about 1827. They are of th following lengths: The north head wall 1,740 feet; the middle head 84 feet, and the south head 380 feet. In 1865 and 1869 these walls wer partly rebuilt, and in the weakest places were backed with concrete All these walls were originally built dry, and they have from tim to time required repairs. On the 30th of June, 1885, the necessary repairs were estimated to cost $150. These repairs were made in October, 1885. No other work was in progress during the fiscal year. Th present condition of these walls is as follows: The north head wall is i fair order; in the middle head wall about 50 feet of the paving in rea of the wall, near its northern end, requires relaying, and 105 feet of th coping stones, near the southern end, must be reset (the stones hav been thrown off the wall and the paving in rear of them injured); the repairs will cost, it is estimated, $750. At the south head wall, nea its northern extremity, about 75 feet of the wall has been demolishe by the winter storms, and requires entire rebuilding, and, for an additional length of 60 feet, one or two courses require resetting. These repairs are estimated to cost $3,000, but in view of the value of this south head in the defense of the harbor it would seem better policy to rebuil this wall, which would cost, for 250 feet of new wall at $75 per foot, an including about 10 per cent. for contingencies, $20,000.

Long Island.—The north head of this island was protected by a granite sea-wall 2,081¾ feet long, completed in 1874. The foundation of the sea-wall and its southern and western ends are protected by an apron of rubble-stone aggregating 1,375 feet in length. This apron was buil in 1874 and extended in 1884. All was in fair order June 30, 1885, a which date it was estimated to cost $400 to make some repairs to th pointing of the masonry. During the fiscal year no operations were i progress. The present condition of the work is as follows: The wal and riprap are in good order, but some repointing should be done, which is estimated to cost $1,000, and the southeastern riprap shore protection should be extended 250 feet. This is estimated to cost $2,000.

Rainsford Island.—The north head of this island had been protected by a dry granite wall 1,500 feet long, originally built in 1840, and extensively repaired in 1884-'85. It was in excellent order June 30, 1885. No work was done on it during the fiscal year, and none is anticipated to be necessary during the year ending June 30, 1888.

Castle Island.—This island had been protected by a dry granite sea-wall 3,300 feet long, built in 1835, and a high riprap extension of it to the southwest 300 feet long, built about 1865. June 30, 1885, the riprap shore protection was in good order, and the wall required some repairs, which were estimated to cost $350. No work was done during the fiscal year. The present condition of the work is as follows: The riprap is in good order, but about 100 feet of the sea-wall has undermined and requires taking down and relaying. This will cost, it is estimated, $1,000.

Governor's Island.—The bluffs and shore-line of this island have never been protected. They stand, however, in very important relations to the main ship channel at the Upper and Lower Middles. In addition to this the bluffs are occupied by important heavy batteries for the defense of the inner harbor and the navy-yard. Serious abrasions of these bluffs have been in progress for some years. The two main bluffs, the east and south, should at once be protected by light sea-walls. That at the east battery will be 500 feet long, and is estimated to cost $30,000; the south bluff wall should be 1,800 feet long, and is estimated to cost $50,000.

WORKS OF IMPROVEMENT.

The condition of the works of improvement on June 30, 1885, was as follows:

The main ship-channel had been widened, straightened, and deepened by dredging and the removal of sunken rocks so that it was nowhere less than 600 feet wide and 23 feet deep at mean low water; originally it was but 100 feet wide and 18 feet deep.

In effecting this improvement to the main ship-channel dredging and blasting was done at the following places (reference being had to the plan of the harbor accompanying Report of the Chief of Engineers for the year 1883):

At Nashe's Rock Shoal, during the years 1876–'78, 365 yards of ledge were removed.

At Kelly's Rock and Shoals, during the years 1869 to 1879, 222 cubic yards of ledge were removed.

Tower, Corwin, and Channel rocks were removed during the years 1867–'75; they aggregated 608¾ cubic yards.

From the west end of Brewster Spit, during the years 1874–'76, 29,226 cubic yards of sand and gravel were dredged and 95½ cubic yards of ledge were removed.

At Lovell's Island, from the southeast and southwest points, 267,294½ cubic yards were dredged during the years 1867–'77.

At Castle Island Bar and Shoals, opposite the lower middle, during the years 1880 and 1883, 36,957 yards were dredged and 20 tons of rock were removed.

At the Lower Middle, 1874–'75, State and Palmyra rocks were removed. They aggregated 62 cubic yards.

At the Upper Middle, during the years 1870 to 1876, 268,278½ cubic yards were dredged and 118½ cubic yards of ledge were removed.

At Anchorage Shoal, during the years 1879 to 1882, 65,327 cubic yards were dredged.

At Man-of-War Shoal, 85,917 yards were dredged in the years 1878–'80.

At Mystic River Shoal, during the years 1879–'82, 82,082 cubic yards were removed.

This improved main ship-channel extends through the lower and upper harbors.

The improvements along it in the lower harbor, with the exception of the dredging at Great Brewster Spit, have been apparently permanent. The exact condition of this part of the channel will be shown by, and any project for its further improvement based upon, the results of the survey made during the last year, the notes of which are not yet fully plotted.

In the upper harbor the improvements of the channel have been pe manent and show no deterioration. The original project of 1867 pr vided for a channel in this part of the harbor 1,000 feet wide and feet deep. This project has been carried out so far that the channel now 600 feet wide only and 23 feet deep. It should be at once widen to 800 feet, which it is estimated will require the dredging of 253,2 cubic yards (scow measurement), at a cost of $128,000.

In addition to these improvements of the main ship-channel throug the upper and lower harbors dredging and blasting had been done i the following tributary channels:

1. *Charles River.*—The original project for the improvement of th river consisted in straightening, widening, and deepening the chann first, from its mouth up to the Western Avenue Bridge (a distance about 4⅝ miles), so that there should be a minimum depth of 7 feet mean low water, with a width of 200 feet; second, from Wester Avenue Bridge to Market Street Bridge (3¼ miles), so that the lea width should be 80 feet, and the least depth 6 feet at mean low water and third, from Market Street Bridge up to the dam at the head tide-water (1⅝ miles) so that the least width, should be 60 feet and th least depth 2 feet at mean low water.

The original estimated cost of this improvement was $85,000. Thi estimate was revised in 1881 and then made $125,000.

The following amounts were specially appropriated for this improv ment:

By act of June 14, 1880	$22,5
By act of March 3, 1881	35,0
Total	57,5

The total amount expended to June 30, 1885, was $55,398.18.

The condition of the improvement on the 30th June, 1885, was as fol lows:

The projected improvement had been completed from the mouth the river up to the Arsenal Street Bridge, a distance of 7¼ miles. Wor was stopped at this point for the reason that the draws and piers of thi bridge do not conform to the projected channel above it; 127,971 cubi yards were dredged during the years 1880–'84.

No work was done during the fiscal year. This improvement, so far as completed, is not regarded as an important benefit to commerce, for the reasons given in the Report of the Chief of Engineers for the year 1884.

The balance, available July 1, 1886, $2,018.49, is not sufficient to continue the improvement, and will be expended in surveys and examinations of the work.

To complete the improvement to the head of tide-water, in accordance with the existing project, will require the expenditure of $116,000. Of this amount $50,000 could be expended to advantage during the fiscal year ending June 30, 1888, in continuing the improvement above Arsenal Street Bridge, provided the draws of the two bridges on that part of the river are rebuilt, to conform to the projected channel.

2. *Hingham Harbor.*—The original project for the improvement of this harbor was made in 1874; it provided for a channel 100 feet wide and 8 feet deep at mean low water up to the wharves in Hingham. The cost was estimated to be $10,000. By the act of 1875, in the appropriation for Boston Harbor, it was provided that not exceeding $10,000 should be spent in Hingham Harbor. During the years 1875–'76 and 1884 25,160

cubic yards were dredged and 83 cubic yards of ledge were removed, at a cost of $9,316.58, and the projected improvement was completed.

3. *Nantasket Beach Channel.*—The project adopted in 1880 was to widen and deepen the channel, so that it should not be less than 100 feet wide and 9½ feet deep at mean low water. During the years 1881 and 1883, 41,922 cubic yards were dredged, and 54 yards of ledge were removed; completing the proposed improvement.

4. *Channel between Nix's Mate and Long Island.*—In 1883, 19,899½ cubic yards were dredged at this point, by which a channel 12 feet deep at mean low water, and 200 feet wide was obtained. This is a very important interior channel, and its usefulness in connection with the mean ship-channel will be much enhanced when its width and depth have been increased, and its proper direction determined after study of the new survey.

5. *Barrel Rock.*—An obstruction on the north side of Broad Sound was removed in 1869; it contained 116 cubic yards.

During the fiscal year ending June 30, 1886, operations have been limited to the following:

Repair of Deer Island sea-walls, noted above, and hydrographic survey of a portion of the lower harbor. This survey was authorized by Department letter of August 6, 1884. It was to include portions of the main ship-channel south of Boston Light, Brewster Bar and its slopes, the Narrows, Nix's Mate bar, and the flats west of Lovell's Island. The survey was commenced May 29, 1885, and the field-work was closed November, 1885. Reduction of soundings, drift studies, &c., were made during the winter, and the plotting of the notes was commenced in May, 1886, and continued as rapidly as the reduced office force would permit. No results can be as yet deduced from this survey, and it may be found necessary to slightly extend the lines of soundings running northwest from Nix's Mate, for the purpose of determining more accurately the direction to be given to the new channel on that side.

A complete study of the condition and requirements of the main ship-channel would necessitate a survey of the channel near the upper and lower middles; this is estimated to cost $3,000, and should be done as soon as funds are available.

The balance available July 1, 1886, is $3,976.41, and will be applied to the completion of the chart of the late survey.

The amounts recommended for expenditure for Boston Harbor during the fiscal year ending June 30, 1888, are as follows, viz:

For extension of the sea-wall at Point Allerton, 150 feet, at $100	$15,000
For repair of Great Brewster wall	3,000
For extension of George's Island sea-wall, 1,400 feet	35,000
For repair of George's Island sea-wall	100
For repair of Lovell's Island east sea-wall	6,000
For extension of Gallop's Island sea-wall	7,500
For repair of middle head-wall, Deer Island	750
For rebuilding south head-wall, Deer Island, 250 feet	20,000
For extending riprap shore protection at Long Island	2,000
For repair of Long Island sea-wall	1,000
For repair of Castle Island sea-wall	1,000
For protection of east bluff at Governor's Island, 500 feet, at $60	30,000
For protection of south bluff of Governor's Island, 1,800 feet	50,000
For continuing the project of improvement of the main ship-channel, by removing 253,200 yards at the Upper and Lower Middles, making it 800 feet wide and 23 feet deep at mean low water	128,000
For survey of Upper and Lower Middles	3,000
For contingencies	17,650
Total	320,000

The several works completed and projected for the improvement this harbor are located in the collection district of Boston and Charle town, Mass. Boston is the port of entry.

The accompanying commercial statistics for the fiscal year endi June 30, 1886, have been furnished by the collector of customs at Bo ton, Mass.:

Money statement.

July 1, 1885, amount available		$8,528
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,537 58	
July 1, 1886, outstanding liabilities	15 00	
		4,552
July 1, 1886, amount available		3,976
Amount appropriated by act approved August 5, 1886		56,250
Amount available for fiscal year ending June 30, 1887		60,226
Amount (estimated) required for completion of existing project		263,750
Amount that can be profitably expended in fiscal year ending June 30, 1888		264,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Custom-House, Boston, Mass.,
Collector's Office, July 20, 1886.

Sir: In compliance with your request of May 25, I inclose report of the trans tions of commerce and navigation at this port during the fiscal year ending June 1886.

The records of that time in this office were not consolidated until to-day.

In noticing your further request, I can only wish you such success in your effort as will make this port the most safe and desirable on the Atlantic coast.

Very respectfully, etc.,

L. Saltonstall,
Collector.

Lieut. Col. G. L. Gillespie,
Engineer Corps, U. S. A.

TRANSACTIONS OF COMMERCE AND NAVIGATION AT THE PORT OF BOSTON DURI THE FISCAL YEAR ENDING JUNE 30, 1886.

Importations:	
Merchandise, value	$58,430,707
Coin and bullion	121,995
Domestic exportations:	
Merchandise	53,428,513
Coin and bullion	1,000
Foreign exportations (re-exports):	
Merchandise	670,555
Coin and bullion	None
Vessels arrived from foreign ports:	
Number	2,592
Tonnage	1,183,067
Vessels cleared for foreign ports:	
Number	2,498
Tonnage	1,918,911
Total custom collections:	
From all sources	$21,079,311
Hospital dues included in above	424

B 5.

IMPROVEMENTS OF PLYMOUTH HARBOR, MASSACHUSETTS.

I relieved Maj. C. W. Raymond, Corps of Engineers, U. S. A., of the charge of this work February 4, 1886, in accordance with Special Orders No. 16, Adjutant-General's Office, dated January 20, 1886.

The object of this improvement is to protect the harbor by the preservation of Long Beach and to deepen and widen the channels of approach to the wharves at Plymouth.

The preservation of Long Beach has been carefully attended to for many years, as the existence of the harbor depends on it, and from the nature of the work it can at no time be considered completed and permanent; small annual appropriations are necessary to immediately repair any damage caused by storms.

The various devices employed for this purpose are described in the Annual Report of the Chief of Engineers for 1877.

The project for the improvement of the main channel was originally adopted in 1875. It provided for straightening the channel so that its total length would be 2,286 feet, gave it a width of 100 feet and a depth of 6 feet at mean low water. This project was modified in 1877 so as to include the dredging of a basin 866 feet long, 150 feet wide and 8 feet deep in front of the city wharves. This modified project was estimated to cost $41,500. The project was again modified in 1884. It was then proposed to dredge the channel to a depth of 9 feet at mean low water, widen it to 150 feet, and round off its junctions with the main ship-channel and the basin. In 1885 it was proposed to deepen the basin to 9 feet at mean low water.

This modified project required the excavation of 81,000 cubic yards (scow measurement), and was originally estimated to cost $27,000.

This amount was revised in 1885, in accordance with the low prices for dredging then current, and the cost of the work was then estimated to be $22,500.

Before improvement the channel to the town wharves was about 6 inches deep at mean low water.

From 1866 to 1884, inclusive, the following allotments or appropriations were made for this improvement:

Amount allotted in 1866 from appropriations made July 2, 1864, for harbors on the Atlantic coast	$8,300
Amount allotted, act of July 25, 1868	7,500
By river and harbor act of July 11, 1870	10,000
March 3, 1871	10,000
June 10, 1872	2,500
March 3, 1873	3,000
June 23, 1874	5,000
March 3, 1875	10,000
June 18, 1878	5,000
March 3, 1879	3,500
June 14, 1880	10,000
March 3, 1881	10,000
August 2, 1882	14,000
July 5, 1884	10,000
Total	108,800
Of which amount there had been expended to June 30, 1885:	
For beach protection	70,329 75
For dredging	35,152 75
Total	105,482 50

The condition of the improvement June 30, 1885, was as follows:

Long Beach was essentially in good order.

The dredged channel was 90 feet wide and 9 feet deep, with ro
junctions at the basin and main channels.

The basin originally dredged to 8 feet depth had shoaled to a
age depth of 7 feet. This shoaling was caused by the lower
Town Brook immediately after the basin was excavated, and
crease of shoaling has been discovered since that time.

During the fiscal year ending June 30, 1886, operations have
confined to repairing Long Beach. The storm of December 26,
caused extensive damage to the southerly part of the beach. A
different points, from Eel River Bridge to a point 4,000 feet north
large breaches were made in the beach. The sand and gravel th
out by the sea was thrown into Eel River, damming it up, and thr
ing to give it an outlet directly into the sea to the consequent inj
the harbor. Private parties removed those dams and re-estab
the original course of the stream. The gaps in the beach were
with brush and stone bulkheads (under direction of this office), a
gating 476 feet in length, with 22 jetties, each 15 feet long.

These bulkheads consist of a triple row of 7 by 7-inch posts,
long, set generally 4 feet into the sand and 5 feet apart. The
braced, top and bottom, in both horizontal directions, by 2 by 3
strips spiked on.

Spurs or jetties 15 feet long, and the same distance apart, sim
built, project from the front and rear. The bulkheads and spur
filled with brush, which is loaded with bowlders taken from the b
An apron of bowlders about 5 feet wide is placed at the outer e
the spurs, extending the whole length of the bulkhead.

A survey of the beach covering that portion repaired during the
and connecting with previous surveys of the northern end of the b
was made during the latter part of June, 1886. The resultant
accompanies this report.

The whole length of beach is now in good order.

The balance available July 1, 1886 ($1,059.69) it is proposed to re
for any urgent necessary repairs of Long Beach that may occur.

To complete the modified project will require the appropriati
$21,500, all of which could be profitably expended during the fisca
ending June 30, 1888, in the following manner:

Widening the channel to 150 feet and deepening it to 9 feet, 44,574 cubic yards	
Deepening the basin to 9 feet, 20,000 cubic yards	
Contingencies	
Total	

This work is located in the collection district of Plymouth, Mass., of whi
mouth is the port of entry. The nearest light-houses are the Plymouth (G
lights, about 5 miles from Plymouth, and Duxbury Pier Light, distant about

The accompanying commercial statistics for the fiscal year e
June 30, 1886, have been furnished by the collector of customs f
port of Plymouth, Mass.

Money statement.

July 1, 1885, amount available		$3
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,900 63	
July 1, 1886, outstanding liabilities	357 18	
		2
July 1, 1886, amount available		1
Amount appropriated by act approved August 5, 1886		6
Amount available for fiscal year ending June 30, 1887		7

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U. S. Engineer (
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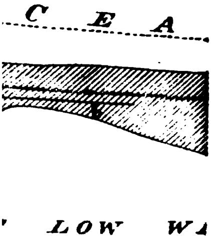
To accompany a



Amount (estimated) required for completion of existing project........ $15,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 15,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, PLYMOUTH, MASS.,
Collector's Office, June 30, 1886.

SIR: I have the honor to forward to you a report of receipts and disbursements of venue at this port, the amount of merchandise in bond, domestic arrivals and clearces, composition of cargoes, arrival and departure of all vessels for a harbor and herwise, estimated number of passengers by steamers, &c., estimate amount of anual business of the port, and Government property here located, and other statistics at may be of possible value to you in your official estimates.

venue:

Official collections from all sources	$30,901 25
Disbursements	2,442 43
Net amount	28,458 82

reign imports:

	Pounds.
Rivet rods	2,130,302
Basic steel	1,874,205
Salt	22,400
Wool	2,778
Total	4,039,685

oreign exports:

Cordage	76,848

emaining in bond:

Rivet rods	1,344,228

Articles.	No. of cargoes.	Tons.
DOMESTIC IMPORTS.		
al	65	17,680
rap-iron	12	2,091
umber	24	4,000
sh	9	300
y	9	670
lding sand	1	200
anite	2	200
r	1	150
scellaneous (by packets, steamers, &c.)	90	12,000
Total	213	37,291
DOMESTIC EXPORTS.		
ood	10	700
ils	9	650
h	2	175
rrels	4	70
avel	43	3,800
Total	68	5,395

SUMMARY.

mber of cargoes: imports and exports	281
ns of merchandise: imports and exports	42,686
riving and sailing of all vessels for harbor and other purposes, estimated number	2,300
mber of passengers arriving and departing by steamers, packets, &c., estimated	45,000

BONDED WAREHOUSES.

There are seven bonded warehouses, in which are stored foreign goods now in bond, in charge of Government.

GOVERNMENT PROPERTY AT THIS PORT.

One double light-house at Gurnet Head.
One single light-house at Duxbury Pier.
One first-class life-saving station at the Gurnet.
One first-class life-saving station at Manomet Point.
One rented custom-house, with furniture, records and files dating from 1773 to date.
One rented post-office and contents.

All thus far enumerated is property in Government hands at this port, all of which is directly benefited by Government surveys and appropriations.

As this is the first and probably the only statement we shall have the honor to forward to you, we have taken the liberty to add to it the business statistics of the port, by which you will see that it is largely dependent on its harbor facilities, and that appropriations and surveys by Government have been turned to good account, and that there is still room for further improvement.

MANUFACTURING INDUSTRY.

The aggregate capital of twenty-two of the principal manufactories amounts to $2,017,000, manufacturing cordage, cottons, woolens, duck, iron, nails, tacks and rivets, zinc, castings, and other staple goods, valued annually, $3,372,000.

The aggregate banking capital is $3,335,377. All this capital receives a direct benefit from the improvements and protection of this harbor by the General Government.

Through the fostering care of the Government and the deepening and widening of its channel it has already become a noted sea-side resort, and the steadily increasing number of visitors for business and pleasure by steamers from Boston and elsewhere that are daily landed here gives the best evidence that what has thus far been accomplished by Government is, as it should be, well appreciated in all its parts, and of great benefit not only to the town, but to the community at large.

As the Department calls for "suggestions," we would respectfully suggest that Long Beach, that forms the protection of Plymouth Inner Harbor, was severely injured in the storms of the last winter; and whatever is done for the benefit of this harbor, Long Beach should be the first object of attention, as without it our harbor would be but an open "sea-way," and thus become useless to navigation and an injury to the town almost beyond estimation. We would suggest that if the appropriation of $6,000 now before the House should be granted, that so far as is wanted it should be used for this especial object.

The channel cut by the Government requires more width and depth to make it the more useful, but Long Beach is of the most importance. We only make the above suggestions from the fact they are called for, as we believe that Government engineers are the best and only sure evidence in all cases where needed.

Very respectfully, your obedient servant,

SAMUEL H. DOTEN,
Collector of Customs.

G. L. GILLESPIE,
Major of Engineers, Bvt. Lieut. Col., U. S. A.

B 6.

IMPROVEMENT OF PROVINCETOWN HARBOR, MASSACHUSETTS.

I relieved Maj. C. W. Raymond, Corps of Engineers, U. S. Army, of the charge of this work February 4, 1886, in accordance with Special Orders No. 16, Adjutant-General's Office, January 20, 1886.

The object of this improvement is to preserve one of the most valuable harbors of refuge on the Atlantic coast. The entire commerce of New England and a very large local fishing interest is directly benefited by its maintenance. It is situated at the extremity of Cape Cod, and its existence depends entirely on the preservation of the sandy beaches inclosing it.

The project for its improvement was adopted in 1866, and modified in 1869, 1872, and 1873. It consists in the construction of detached bulkheads of wood and stone, jetties of wood and brush, dikes, sand-catch fences, and the extensive planting of beach grass—all for the sole purpose of preventing or arresting the movement of the sand by the winds and waves. A full history of these improvements will be found in the Annual Reports of the Chief of Engineers for the years 1876 and 1879.

While the harbor on the east side covering East Harbor and the salt meadow has been made secure by dikes and bulkheads constructed by the Government and by the State, the west side has been left comparatively unimproved, except at the eastern extreme end of Long Point and at Lancy's Harbor, adjacent to Abel Hill. Between these two last points there is but a slight fringe of beach separating the harbor from the ocean on the outside, through which the seas frequently penetrate, threatening extensive crevasses in this natural bulkhead. These sea encroachments tend to level the beach as well as to open swales through it, and it would be a wise policy to commence at an early day an improvement which will have for its object to unite Long Point with the mainland at Stevens Point by a substantial timber and stone dike, which will oppose a strong front to the sea action and assist in building up the intervening flats. An estimate for this improvement accompanies this report.

Since 1866 the allotments or appropriations for this harbor have been as follows:

Amount allotted in 1866 for appropriation made for harbors on the Atlantic coast by act June 28, 1864	$30,000 00
Appropriated by act of June 23, 1866	43,068 44
Appropriated by act of July 28, 1866	8,000 00
Allotted from appropriation, river and harbor act of April 10, 1869	8,910 00
Appropriated by act of—	
March 3, 1871	6,000 00
June 10, 1872	5,000 00
March 3, 1873	6,000 00
June 23, 1874	6,000 00
March 3, 1875	5,000 00
August 14, 1876	4,000 00
June 18, 1878	1,000 00
March 3, 1879	1,000 00
June 14, 1880	500 00
March 3, 1881	5,000 00
August 2, 1882	5,000 00
July 5, 1884	2,000 00
Total	136,478 44

The amount expended to June 30, 1885, was $135,924.59.

The condition of the improvement June 30, 1885, was as follows (see accompanying map):

Long Point.—This long, narrow, low point forms the southwestern limit of the harbor. It had been protected on the southeast or outside by bulkheads, groins, and aprons, built of rubble-stone. These were all generally in good order. No work was done here during the year ending June 30, 1886. The advance of the point in a southeast and northeast direction is very marked. The bulkhead should be backed up with small granite chips and brush, to retain the sand thrown up, and about 600 tons of additional large stone is required to "level up" the bulkhead.

Beach Point.—This beach lies between the main and East Harbors. It had been thoroughly protected by bulkheads and jetties and was in excellent order. No work has been done here during the year, and none probably will be necessary during the next year. This beach has steadily improved in height and strength since the State dike closin bor entrance was completed in 1870.

High Head Dike.—This dike was in good order. It is sit head of East Harbor, between it and the "Salt Meadow." in 1869, for the purpose of arresting the rush of the sea sho through at the "Cove Section." No work was done on it year and none probably will be needed during the next yea

Cove Section, a narrow, low part of the outer beach at the "Salt Meadow." The beach here had continued to incre and height. No work was done here during the year, and bly will be needed during the next year.

Abel Hill Dike, a dike built to prevent a rush of water fro Harbor" over House Point Island Flats into the main ha dike was in good order. During the year ending June 3 work was done. The brush bulkheads to the southward of Dike should be repaired and extended about 50 feet on it end. This is estimated to cost $200.

House Point Island Flats.—These flats have for many y steadily moving to the southeast, to the manifest injury of t In November, 1885, House Point Island was swept away b storm. No work of preservation was done during the year. of these flats and the adjacent harbor was in progress durin The field-work was closed in February, 1886, as no more f then available. The information gained by the survey, in with a late personal examination of the flats, enable me to s project for the preservation of the harbor will be effectiv promise of permanency, which does not involve the constru strong dike from Stevens Point, across the flats, to near Lob a distance of one mile approximately. Such a dike, with the ments already made at Long Point, would effectually seal t against storm encroachments, and would cause such exten accumulations on the northwest side as to raise the flats plane of any known tides. It should be located along the hig on the east side, and should be constructed of a double row filled with brush and stone. It is estimated to cost $15 per foot, or an aggregate of $80,000.

The accompanying chart shows the location and dimension proposed dike.

The balance available July 1, 1886, is $4.54, not sufficient to c the improvement.

During the year ending June 30, 1888, the following sums c expended to advantage:

The construction of 5,200 feet of timber dike, connecting Stevens and Lobster points, at $15 per foot..
To complete the backing of the Long Point breakwater..................
To restore the height of the Long Point breakwater, 600 tons, at $3.....
To complete survey ....
To repair and extend bulkheads at Abel Hill 50 feet, at $4...............
For immediate repair of probable storm damages...........................
Contingencies...

Total..

Provincetown is a port of entry in the collection district of Barnstable, The nearest light-houses are Long Point and Wood End lights.

The accompanying letter of the deputy collector at the port of incetown furnishes the commercial statistics for the fiscal year e June 30, 1886.

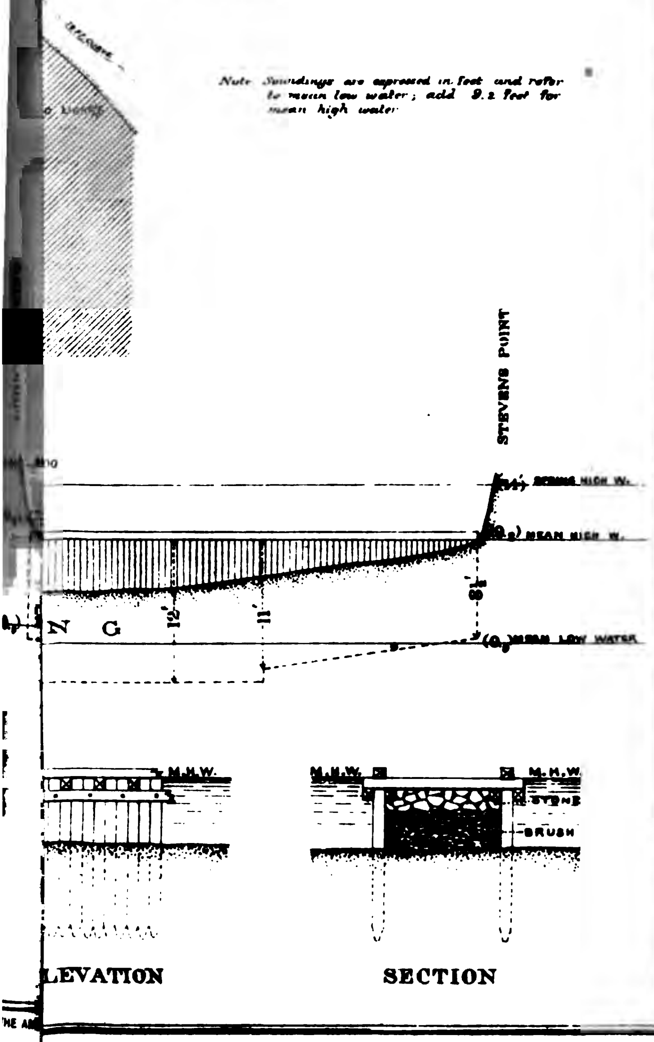
INCETOWN HARBOR, MASS.

etch showing location of works of
provement completed and proposed

At a, Brush bulkhead and jetties at Cove Section built in 1873-74
" b, U.S. Dyke at High Head, built in 1869-1870
" c, Brush and plank bulkheads, brush jetties and stone
groins at Beach Point built in 1869 - 1875.
" d, Massachusetts State Dyke built in 1868 - 1869.
" e, Stone bulkhead and groins on Long Point built in 1870-1884
" f, Plank bulkheads and jetties at Long Point built previous to 1871.
" g, Transplanted marsh from Stevens Pt to Lobster Pt and elsewhere
" h, U.S. Dyke at Abel Hill built in 1871-1872
" k, Catch-sands on Beach near Abel Hill built in 1885
" l, Proposed Dyke between Stevens Pt and Lobster P
Beach grass has been planted at a, b, c, d, f, h and

SCALE OF MAP (1:30000)

Note. Soundings are expressed in feet and refer to mean low water; add 9.2 feet for mean high water



Money statement.

1, 1885, amount available	$553 85
1, 1886, amount expended during fiscal year, exclusive of liabilities tstanding July 1, 1885	549 31
1, 1886, amount available	4 54
unt appropriated by act approved August 5, 1886	3,000 00
unt available for fiscal year ending June 30, 1887	3,004 54
ount (estimated) required for completion of existing project	90,000 00
ount that can be profitably expended in fiscal year ending June 30, 1888	90,000 00

bmitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

DEPUTY COLLECTOR'S OFFICE,
Port of Provincetown, June 30, 1886.

R: In compliance with your directions of the 27th ultimo, I would state the ount of revenue collected at this office for the year ending this day was $708.24.

	Tons.
mber of foreign entries at this office, 32	2,704
mber of foreign clearances, 34	2,886
mber of coastwise clearances, 8	810
mber of entrances of merchandise in bond	34

Including 142 sail vessels and 1 steamer belonging to this port, whose aggregate nnage is 12,541 tons, the number of vessels that entered and departed from this port ring the year was, as nearly as could be estimated, 7,000.

The estimated value of commerce and navigation that sought shelter in Provincewn Harbor during the past year was $18,500,000.

Respectfully,

JAMES GIFFORD,
Deputy Collector.

F. B. GOSS, Esq.,
Collector of Customs, Barnstable.

B 7.

IMPROVEMENT OF LYNN HARBOR, MASSACHUSETTS.

I relieved Maj. C. W. Raymond, Corps of Engineers, U. S. Army, of he charge of this work February 4, 1886, in accordance with Special rders, No. 16, Adjutant-General's Office, dated January 20, 1886.

The object of the improvement is to obtain an increased depth of ater and a more direct and wider channel of approach to the city harves. Before the improvement there was about 6 feet at mean low ater in the channels which were narrow and crooked.

The project was adopted in 1884. It provides for the excavations of channel 200 feet wide and 10 feet deep at mean low water, from a point ear and east of the White Rocks to deep water opposite Little Nahant, r 3,610 feet in length of this the lower channel. The upper channel, ,450 feet in length, extends from deep water opposite Sand Point to he Lynn Harbor line, with the same width and depth. It is supposed hat the upper or western part of the upper channel will have to be aintained by occasional dredging. To aid in keeping the lower channel open, a training-wall is proposed, which is to join the land at Little ahant if experience shows that its construction is necessary.

The cost of this improvement was originally estimated to be $14
This estimate was revised in 1885, and the total cost was then
to be $157,000—an increase of $12,000, due to an additional
of dredging found to be necessary in rounding off the junctions
dredged channels with deep water, in providing slopes for the
the dredged channels, and to provide for surveys and inspection

But one appropriation has been made for this work, viz:

By river and harbor act of August 2, 1882 .... $6
The amount expended to June 30, 1885, was 5

The condition of the improvement on June 30, 1885, was as fo
The lower channel, 3,610 feet long, had been dredged to a width
feet and a depth of 10 feet at mean low water, from near White
to deep water opposite Little Nahant; and the upper channel
feet long, had been dredged 100 feet wide and 10 feet deep at me
water, from deep water opposite Sand Point to the Lynn Harb
About 170,500 cubic yards were removed by contract, which was
December 20, 1884.

No operations were in progress during the fiscal year ending J
1886, but close comparative surveys were made of the dredged
by which it appears that no material change has taken plac
channels, although in one or two places a slight decrease in
channel is noticed, owing to the falling in of the side slopes,
juries caused by vessels getting aground.

To complete the work, including the training-wall, would req
appropriation of $97,000. But it seems more desirable to rep
complete the upper channel to its full width and depth, and
further developments before building the wall. To effect this
quire the removal of about 160,000 cubic yards of material at
mated cost of $32,000.

This work could be advantageously done during the fiscal yea
June 30, 1888, and for this purpose the following appropriat
recommended, viz:

For removal of 160,000 cubic yards of material from the upper channel, making it 200 feet wide and 10 feet deep at mean low water, at 20 cents.
Contingencies ....

Total ....

The balance available July 1, 1886, is $7,035.09, part of whic
required for surveys, &c., leaving $30,000 to be appropriated
plete the work so far as now recommended.

Lynn is a port of entry in the Marblehead collection district. The nea
house is Egg Rock (Nahant) Light, distant about 3 miles.

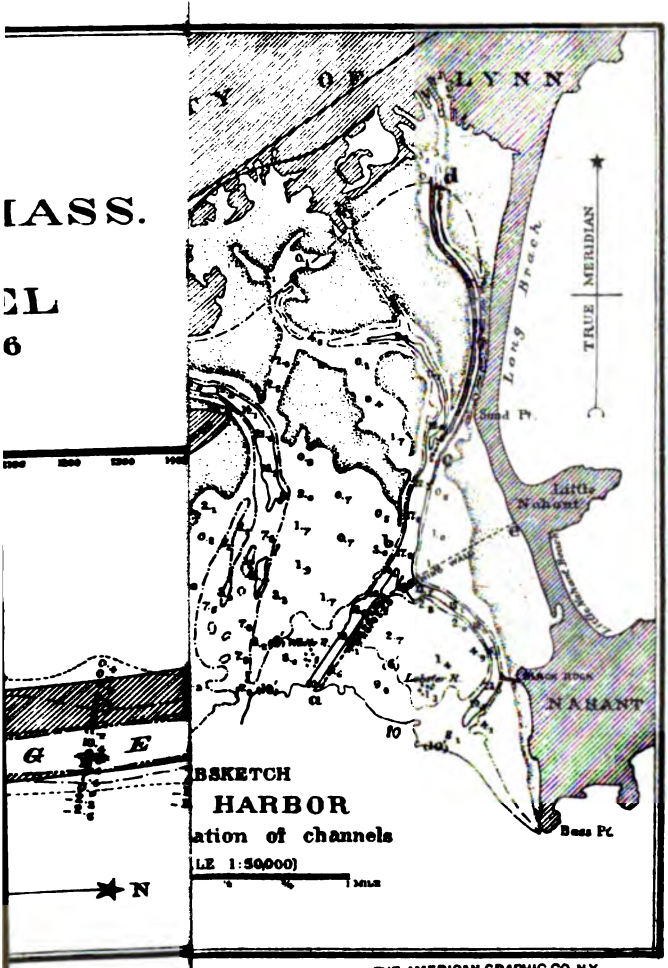
The accompanying commercial statistics for the fiscal yea
June 30, 1886, have been furnished by the collector of custom
port of Marblehead, Massachusetts.

Money statement.

July 1, 1885, amount available ....
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885 ....

July 1, 1886, amount available ....
Amount appropriated by act approved August 5, 1886 ....

Amount available for fiscal year ending June 30, 1887 ....



THE AMERICAN GRAPHIC CO., N.Y.

ount (estimated) required for completion of existing project	$91,000 00
ount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00

bmitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

ber of vessels arriving from foreign ports during the year ending June , 1886	26
s tonnage of said vessels	2,647
e of merchandise imported in said vessels	$9,641
unt of revenue collected in Lynn during the fiscal year ending June , 1886	$1,343
ber of coastwise arrivals during the year	415
unt of coastwise tonnage	82,585
e of merchandise brought to Lynn in coastwise vessels	$774,500

This amount of $774,500 includes these items:

l	$590,000
ber	90,000
e-wood	3,500
e and cement	36,000
e, sand, and bricks	15,000
cellaneous, hay, tiles, water-pipes, paving and crossing stones, drain pipes	40,000
Total	774,500

B 8.

IMPROVEMENT OF MALDEN RIVER, MASSACHUSETTS.

I relieved Maj. C. W. Raymond, Corps of Engineers, U. S. Army, of he charge of this work February 4, 1886, in accordance with Special rders, No. 16, Adjutant-General's Office, dated January 20, 1886.

The object of the improvement is to increase the width and depth of he river channel from its mouth up to the second draw-bridge in Mal-len.

Previous to the improvement there was a navigable depth of barely 7 feet at mean low water (the mean rise and fall of the tides is 9.8 feet), nd the channel was narrow and crooked.

The project was originally proposed in 1880. It contemplated the xcavation of a channel 100 feet wide and 12 feet deep at mean high water up to the second draw-bridge, with two cut-offs, one east of the island, near the junction of The Malden and Mystic rivers, and the other through the marsh land, about half a mile above.

This project was modified in 1882, when it was proposed to excavate a channel, following the natural bed of the river, which should have a depth of 12 feet at mean high water 100 feet wide, up to the draw-bridge in Malden, and 75 feet wide thence to the second draw-bridge, near the rubber works.

The cost of the adopted project was estimated to be $40,000.

By the river and harbor act of August 2, 1882, Congress appropriated for this work	$10,000
Total amount expended to June 30, 1885	10,000

The cost of this improvement was originally estimated to be $145,000. This estimate was revised in 1885, and the total cost was then stated to be $157,000—an increase of $12,000, due to an additional amount of dredging found to be necessary in rounding off the junctions of the dredged channels with deep water, in providing slopes for the sides of the dredged channels, and to provide for surveys and inspections.

But one appropriation has been made for this work, viz:

By river and harbor act of August 2, 1882	$60,000 00
The amount expended to June 30, 1885, was	50,209 06

The condition of the improvement on June 30, 1885, was as follows:

The lower channel, 3,610 feet long, had been dredged to a width of 200 feet and a depth of 10 feet at mean low water, from near White Rocks to deep water opposite Little Nahant; and the upper channel, 6,450 feet long, had been dredged 100 feet wide and 10 feet deep at mean low water, from deep water opposite Sand Point to the Lynn Harbor line. About 170,500 cubic yards were removed by contract, which was closed December 20, 1884.

No operations were in progress during the fiscal year ending June 30, 1886, but close comparative surveys were made of the dredged areas, by which it appears that no material change has taken place in the channels, although in one or two places a slight decrease in width of channel is noticed, owing to the falling in of the side slopes, or to injuries caused by vessels getting aground.

To complete the work, including the training-wall, would require the appropriation of $97,000. But it seems more desirable to repair and complete the upper channel to its full width and depth, and to await further developments before building the wall. To effect this will require the removal of about 160,000 cubic yards of material at an estimated cost of $32,000.

This work could be advantageously done during the fiscal year ending June 30, 1888, and for this purpose the following appropriations are recommended, viz:

For removal of 160,000 cubic yards of material from the upper channel, making it 200 feet wide and 10 feet deep at mean low water, at 20 cents.	$32,000
Contingencies	3,000
Total	35,000

The balance available July 1, 1886, is $7,035.09, part of which will be required for surveys, &c., leaving $30,000 to be appropriated to complete the work so far as now recommended.

Lynn is a port of entry in the Marblehead collection district. The nearest light-house is Egg Rock (Nahant) Light, distant about 3 miles.

The accompanying commercial statistics for the fiscal year ending June 30, 1886, have been furnished by the collector of customs for the port of Marblehead, Massachusetts.

Money statement.

July 1, 1885, amount available	$9,790 94
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,755 85
July 1, 1886, amount available	7,035 09
Amount appropriated by act approved August 5, 1886	6,000 00
Amount available for fiscal year ending June 30, 1887	13,035 09

* * is worthy of improvement, and that the work is a public necessity."

General Thom's report, dated October 7, 1882, states that the bay was worthy of improvement and the work one of public necessity.

The Chief of Engineers, on April 24, 1883, directed Maj. C. W. Raymond, Corps of Engineers, to prepare plans and estimates for this work.

Major Raymond reported, November 28, 1883, a project for a breakwater, with rubble-stone mound, surmounted by a vertical wall of masonry. The cost was estimated at $4,000,000.

In the river and harbor act of July 5, 1884, the sum of $100,000 was appropriated for this work, with the proviso—

> That a Board of three Engineers, to be appointed by the Secretary of War, shall decide that this point is the best location on the coast between Boston and Portland for such a harbor, that shall serve all the uses for which it may be needed.

The Board of Engineers constituted July 28, 1884, under the provisions of the act of 1884, submitted reports, dated August 23, 1884, and December 11, 1884. The decision of the Board was that Sandy Bay was the best location on the coast, between Boston and Portland, for a harbor of refuge of the first class, and also that the plans recommended for the breakwater by Major Raymond were the best that could be adopted.

On April 15, 1885, interested parties asked the honorable the Secretary of War to direct operations to be commenced. They stated that the expenditure of the sum available would more clearly mark Avery's Ledge, which would be "a very substantial benefit to commerce," and if more funds were provided "one end of the breakwater would be already completed."

The subject was referred to the local engineer, who stated that the construction of a pier on the ledge, "extending above high water, would, without doubt, be a benefit to navigation, whether a breakwater is or is not built in the future."

On May 5, 1885, the Chief of Engineers submitted this report to the Secretary of War, and recommended that the local engineer be called upon "for a project of the pier on Avery's Ledge, the said pier to form the beginning of a breakwater at Sandy Bay, should additional appropriations be made by Congress for continuing its construction in the future."

The recommendation was approved by the Secretary of War, and May 20, 1885, Major Raymond submitted a project for a solid stone pier 30 feet in diameter, rising to 12½ feet above high water, and to cost $46,000.

On June 25, 1885, The Board of Engineers reported that the form and dimensions of the pier proposed by Major Raymond would have sufficient stability, but believed that the cost would be reduced by building the lower part of it of concrete *in situ* inside of a cast-iron ring.

These several reports were submitted to the Secretary of War, and on the 6th of July, 1885, the work of building a pier to mark the site of the ledge, as well as to form one terminus of the proposed breakwater, was ordered to be commenced.

Surveys and preparations of the project were in progress until September 10, 1885, when it was proposed to place on Avery's Ledge two large blocks of concrete which should weigh 371 tons. They were to be constructed on shore, and when dry placed on the ledge. This structure was to extend to the level of half tide, and was to be surmounted by an iron spindle. It was estimated to cost $6,000. The

balance of the funds it was proposed to expend in the con
a portion of the rubble base of the breakwater, commenci
from the initial point and extending northward along the
breakwater for a distance of about 1,282 feet. The top of
base was to be 40 feet wide, and in a plane 22 feet below lo

This project was approved by the Chief of Engineers Se
1885, except that it was directed that the concrete blocks
rise higher than the level of one foot below mean low water.

On September 25, 1885, proposals were invited for placi
tons of rubble-stone in the breakwater.

Six large buoys for service in connection with the placing
crete blocks were moored round Avery's Ledge by contra
August 3, 1885.

Ranges on the salvages for guiding the dumping of the
also established.

On October 26, 1885, the proposals invited for rubble-s
opened. Eight bids were received, the highest $1.67 per to
est 58.3 cents. On October 30, 1885, a contract was entere
the lowest bidder, the Rockport and Pigeon Hill Granite C
Chas. S. Rogers, receiver. Work was commenced by the c
in November, 1885, and during the fiscal year they delive
tons, all of which was dumped between stations 340 and 127

On March 8, 1886, proposals were invited for building a
on Avery's Ledge a concrete block to weigh approximatel
Bids were opened April 15, 1886. Only one bid was receiv
Mr. B. G. Bailey, of New York, which was for $7,707. Th
was not of the required form, and the justification of the g
was not complete; it was rejected.

As the season was too far advanced to readvertise the w
admit of the construction of a sufficiently hardened block i
its sinking before the approach of the variable weather of a
plan of this kind of base for the pier was abandoned, and
termined to substitute for it a spindle, which was absolutel
to give a permanent range for the convenience of the cont
dumping stone.

On March 11, 1886, proposals were invited for a wrought-ir
8 inches in diameter. The bids received were opened March 2
contract awarded to the lowest bidder, the Bridgewater Iron
Company. Their bid was for 5¼ cents per pound. The spind
livered April 15, 1886.

On May 25, 1886, sealed proposals were opened for drilling
Avery's Ledge and erecting therein the iron spindle. This
approved and the contract awarded by Department letter o
1886, to the second lowest bidder, Mr. George W. Townsend, o
Mass., with whom on the 9th of June, 1886, a formal written
was executed for this work.

Work under this contract was commenced June 18, but the
was unable to complete the work during the fiscal year, ow
favorable weather. The contract is still in force.

An apprehension having arisen that it might be impractica
the hole in the rock for the accommodation of the spindle,
cided to make an attempt to sink a cast-iron ring, 23 feet in
and 6 feet high, around the initial point, to be filled with con
to form an anchorage for the spindle as well as to furnish th
the future pier. The great desire was to secure the erecti

spindle, the construction of the pier being only a secondary consideration. This plan was likewise approved by the Department May 14, and immediately thereafter a contract was awarded to Messrs. G. W. and F. Smith, of South Boston, the lowest bidders, for the construction of the iron shell at 3 cents per pound, delivered at Rockport, by July 15; and several minor contracts were made for the delivery of concrete material and of the timber for making shears and other appliances. Work was immediately started on all these contracts, and good progress has been made in perfecting arrangements for the work.

The balance available July 1, 1886, was $57,817.43. It will be applied to the completion of the existing contract for rubble-stone, to the building of the pier on Avery's ledge, and in marking the location of this submerged pier by an iron spindle.

In continuation of the rubble mound substructure of the breakwater during the fiscal year ending June 30, 1888, $500,000 could be advantageously expended.

Sandy Bay is situated in the collection district of Gloucester, Mass. The nearest light-house is Straitsmouth Light, situated on the northeast end o Straitsmouth Island, at the southeast side of the entrance to the bay.

A letter from the collector of customs at Gloucester, Mass., which gives the commercial statistics of this district for the fiscal year ending June 30, 1886, is annexed.

Money statement.

July 1, 1885, amount available		$95,659 97
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$25,284 80	
July 1, 1886, outstanding liabilities	12,557 74	
		37,842 54
July 1, 1886, amount available		57,817 43
Amount appropriated by act approved August 5, 1886		100,000 00
Amount available for fiscal year ending June 30, 1887		157,817 43
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for rubble-stone for Sandy Bay Breakwater, Massachusetts, opened October 26, 1885, by Maj. C. W. Raymond, Corps of Engineers.

No.	Names of bidders.	Price per ton of 2,000 pounds.
1	Rockport Granite Company and Pigeon Hill Granite Company	$0 58$\frac{4}{10}$
2	Charles H. Edwards	68
3	John Cameron	72$\frac{9}{10}$
4	Charles W. Parker and Isaac A. Sylvester	87
5	George E. Runyon	90
6	Samuel R. Cumming and M. J. Dady	99½
7	Charles Guidet	1 51¼
8	David V. Howell	1 67

Contract was awarded to the Rockport and Pigeon Hill Granite Companies with the approval of the Chief of Engineers.

Abstract of proposals for drilling hole in Avery's Ledge, Sandy Bay, Cape Ann, Massachusetts, and inserting an iron spindle therein, opened May 24, 1886, by Maj. G. L. Gillespie Corps of Engineers.

No.	Names of bidders.	Gross sums bid for work.	Remarks.
1	William E. Chapman	$1,275	
2	Adoniram Fairchild	425	Proposal withdrawn by permission.
3	Hugh Bowen	965	
4	Edward McDonald	3,000	
5	George W. Townsend	900	

Contract was awarded to George W. Townsend, with the approval of the Chief of Engineers.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, GLOUCESTER, MASS.,
Collector's Office, July 7, 1886.

SIR: As requested in your favor of May 25, I send you the following statistics in regard to this district:

Tonnage of district, 495 vessels, 31,437 tons.

Number of vessels entered from foreign countries	128
Number of vessels cleared to foreign countries	113
Number of vessels' registers and enrollments granted	98
Number of vessels' licenses	504
Value of imports	$109,256
Duties on imports	$13,827
Number of vessels boarded by inspectors	3,400

(These are nearly all the vessels in the foreign and coastwise trade, as many of our local fishermen are not boarded.)

There is about 50 sail of vessels (fishing and coasting) owned at Rockport (Sandy Bay), and they have 3 or 4 foreign arrivals each year from Nova Scotia.

A sum of money could be expended to good advantage in Gloucester Harbor in making improvements and removing rocks.

Respectfully,

D. S. PRESSON,
Collector.

Maj. G. L. GILLESPIE.

APPENDIX C.

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

REPORT OF LIEUTENANT-COLONEL GEORGE H. ELLIOT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor of Refuge at Hyannis, Massachusetts.
2. Harbor of Refuge at Nantucket, Massachusetts.
3. Wood's Holl Harbor, Massachusetts.
4. Westport Harbor, Massachusetts.
5. Wareham Harbor, Massachusetts.
6. Taunton River, Massachusetts.
7. Pawtucket River, Rhode Island.
8. Providence River and Narragansett Bay, Rhode Island.
9. Green Jacket Shoal, Providence River, Rhode Island.
10. Warren River, Rhode Island.
11. Newport Harbor, Rhode Island.
12. Harbor of Refuge at Block Island, Rhode Island.
13. Little Narragansett Bay, Rhode Island.
14. Harbor of Refuge at Stonington, Connecticut.
15. Pawcatuck River, Rhode Island and Connecticut.
16. Removing sunken vessels or craft obstructing or endangering navigation.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, R. I., July 28, 1886.

GENERAL: I have the honor to submit herewith annual reports for the year ending June 30, 1886, for river and harbor works in my charge.

I was assisted during the year by Assistant Engineer Norman W. Eayrs.

Very respectfully, your obedient servant,

GEORGE H. ELLIOT,
Lieut. Col. of Engineers.

Brig. Gen JOHN NEWTON,
Chief of Engineers, U. S. A.

C 1.

HARBOR OF REFUGE AT HYANNIS, MASSACHUSETTS.

The harbor of Hyannis lies on the south shore of Cape Cod, about 15 miles to the westward of the heel of the cape, and is an important harbor of refuge. The mean rise and fall of the tide is about 3¾ feet.

ORIGINAL CONDITION.

Before improvement it was an open roadstead, exposed to southerly storms.

PLANS OF IMPROVEMENT.

In the years 1827–'38 a breakwater of riprap granite 1,170 feet long was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. It was not as strongly built as we would now build a breakwater in a locality of like exposure, and in the years 1852–'82 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water inside the breakwater is insufficient for many vessels that seek the harbor for refuge, and the river and harbor act of July 5, 1884, provided for a preliminary examination and survey of the harbor, with a view of deepening it. The reports in the case, with a plat and an estimate of the cost ($45,743.20), were printed in House Ex. Doc. No. 96, Forty eighth Congress, second session, and may also be found in the Report of the Chief of Engineers for 1885, Vol. I, pages 560 and 619–'21. The commencement of this work has been approved by Congress making an appropriation of $10,000 therefor in the act of August 5, 1886.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1886.

No work has been in progress during the last fiscal year. The amount expended on this work has been $123,276.77, and the breakwater has been completed according to the original project and the subsequent plans for strengthening it.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

The execution of the project before referred to, of deepening the anchorage area inside the breakwater, will be commenced at the eastern end of the anchorage, and the full width of the area proposed to be deepened will be carried to the westward as far as the appropriation of August 5, 1886, will allow.

Hyannis Harbor is in the Barnstable collection district, and Barnstable is the nearest port of entry. The amount of revenue collected in the last fiscal year was $1,670.92. The main value of the harbor is for a harbor of refuge. The nearest light-house is Hyannis Light; the nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1885, amount available	$105 46
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	24 65
July 1, 1886, amount available	80 81
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,080 81
Amount (estimated) required for completion of existing project	35,662 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,662 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

HYANNIS, *June* 21, 1886.

SIR: I have the honor to report the receipt of your letter of the 17th, and have gathered the following statistics, in compliance with your request, for the year 1885:

IMPORTS.

Coal	tons.	8,000
Lumber	feet.	1,750,000
Cotton	bales.	1,000
Grain	bushels.	108,000
Lime	barrels.	500
Hay	bales.	300

EXPORTS.

Fish, iced	barrels.	42,000
Schooners harboring during year		1,600
English		150
American		1,450
Draught	feet.	3 to 15
Tonnage		25 to 1,000
Steamers harboring during year		210
Tonnage		75 to 500
Draught	feet.	6 to 13

There would probably be a larger number of vessels harbor here if the harbor inside the breakwater was dredged.

Very respectfully,

ALONZO F. LOTHROP,
Keeper of Hyannis Light Station.

Lieut. Col. GEORGE H. ELLIOT.

C 2.

HARBOR OF REFUGE AT NANTUCKET, MASSACHUSETTS.

Nantucket Harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the other (the north) side of Nantucket Sound, the navigation of which is intricate and dangerous by reason of numerous shoals. Nantucket Harbor has deep water inside, and the object of the improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod, estimated at 50,000 annually. In the memorial to Congress on which the first appropriation for this harbor of refuge was based it was stated that more than 500 vessels had been wrecked in the vicinity of the island.

The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before the commencement of the present works there was a shoal about 1½ miles in width outside the entrance, through which shoal the channel or line of best water was only about 6 feet deep, and very crooked, and subject to changes in location.

PLANS OF THE WORKS.

The present approved project is to construct jetties of riprap stone projecting from either side of the present entrance to the harbor for the purpose of concentrating the strength of the tidal currents and excavating a channel of 15 feet depth by scour, and, at the places where the full depth required will not be reached by this means, to complete the work by dredging. A plan of the works may be found in the Report of the Chief of Engineers for 1885, Vol. I, page 578.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended on this project up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $100,211.25, and the result was the construction of the west jetty to a point 3,955 feet from the shore.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. My project for the location of the east jetty and the completion of the works required for making Nantucket Harbor a harbor of refuge for vessels of 15 feet draught and less, with certain modifications proposed by the Board of Engineers for Fortifications and River and Harbor Improvements, having been approved by the Chief of Engineers, advertisements were issued for proposals for furnishing riprap granite for commencing the construction of the east jetty and placing the same in the jetty. The proposals received and the terms of the contract will be found in the appended table.

In September, 1885, the right of way to and from the east jetty by land, the right to connect it with the shore, and to erect temporary buildings for public purposes at the root of the jetty were obtained and placed on record in the office of the register of deeds at Nantucket. Work on the jetty commenced April 29, and continued until the end of the fiscal year, when it was still in progress. The amount of stone delivered during the fiscal year was 2,000 tons.

Careful surveys were made in June last of the bottom of the entrance to the harbor to determine what effect, if any, the west jetty alone had produced on the bar, reports having been received that the water had deepened and that vessels experienced much less difficulty last spring than formerly in crossing the bar at low tide. Our survey fully confirmed these reports.

The lighting of the end of the west jetty, which, until the two jetties are completed and a lighthouse is erected on one of them, will be a source of danger to vessels entering and leaving the port at night, was faithfully attended to during the year.

Mr. Thomas A. Churbuck was local inspector of the work of construction of the east jetty.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1886.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $5,620.87. The east jetty was commenced and fully completed to a distance of 120 feet from the initial point on the shore, which is the outer end of the middle of the three northwest spurs built on Coatue Beach some years ago, and the foundation was laid and the jetty partially completed for an additional distance of 100 feet. The crossing of the deep flood-tide channel, which ran near and parallel to the shore of Coatue, made the construction of this part of the jetty comparatively slow.

Although but little, if any, effect had been expected before the two jetties should have been extended until they should become parallel and contract the channel to the width contemplated, viz, 1,000 feet, it was found in the survey just referred to that on a line from Brant Point to the present end of the west jetty the least depth of water was nearly 1½ feet greater than at the time of our previous survey, and vessels had less difficulty in entering and leaving the harbor.

It is believed that the channel depth would already be much greater except for the "Hog Backs," or slight elevations of the bottom, covered with strong sea-weed which protects the sand from scour. When the channel has become somewhat more contracted by the extension of the east jetty, I design to harrow the bottom in the line of deepest water by the aid of a steamer, for the purpose of breaking up the roots of this sea-weed and stirring up the sand in order to facilitate the action of the strengthened tidal current upon it. The indications are that in this way a considerable deepening of the water in the channel will be produced long before the final contraction of the channel to the width contemplated for it.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work required to be done to complete the existing project is the completion of the east and west jetties, and the excavation by dredging of so much of the channel as will not be excavated by tidal scour.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the extension, as far as possible, of the east jetty.

Nantucket is in the Nantucket collection district, and is a port of entry. The amount of revenue collected in the last fiscal year was $185.02. The value of the harbor is mainly as a harbor of refuge. The nearest light-houses are Nantucket Cliff and Brant Point lights. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1885, amount available		$9,788 75
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,048 81	
July 1, 1886, outstanding liabilities	2,572 06	
		5,620 87
July 1, 1886, amount available		4,167 88
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		19,167 88
Amount (estimated) required for completion of existing project		250,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing riprap granite for the east jetty at Nantucket, Mass., and placing the same in the jetty, received at Engineer Office, United States Army, Newport, R. I., in response to advertisement dated September 26, 1885, *and opened at* 12 *o'clock, noon, on the* 17*th October*, 1885.

No.	Name and address of bidder.	Price per ton.	Remarks.
1	Chas. H. Edwards, Quincy, Mass	$1 96	Work to be commenced within one month after signing of contract, except otherwise agreed in writing, and to be finished on or before June 30, 1886.
2	John A. Bouker, Jersey City, N. J	2 37	
3	Wm. H. Molthrop & Co., New London, Conn.	2 47	
4	James Scully, Groton, Conn	2 50	
5	James V. Luce, East Lyme, Conn	2 78	

Contract awarded to C. H. Edwards, with the approval of the Chief of Engineers, and dated October 26, 1885. Time of commencement extended to April 1, 1886, and time of completion to August 31, 1886.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, NANTUCKET, MASS.,
Collector's Office, June 30, 1886.

SIR: In compliance with your letter of June 17, 1886, I inclose you herewith a statement of imports into this port during the last fiscal year; also a statement of tonnage. The amount of revenue collected at this office during the past year aggregates the sum $185.02.

I have the honor to remain your obedient servant,

ALBERT A. GARDNER,
Collector.

Lieut. Col. GEORGE H. ELLIOT.

Aggregate amount of imports for the year ending June 30, 1886.

Coal, hard	tons..	8,750	Brick	number..	255,[illegible]
Coal, gas	do..	200	Lime	casks..	[illegible]
Railroad sleepers	pieces..	3,500	Cement	do....	[illegible]
Grain	bushels..	27,000	Wood	cords..	[illegible]
Flour	barrels..	4,500	Salt	pounds..	145,[illegible]
Hay	tons..	175	General merchandise	tons..	4,[illegible]
Lumber	feet..	1,800,000			

About 218 vessels entered our harbor during the past year of the following classification:

No.	Class.	Average draft.	Average size.
		Feet.	*Tons.*
112	Schooners	8	115
28	Sloops	6	45
23	Steamers	7	400
7	Barges	6	100
48	Yachts, of various sizes, and rigs		

Very respectfully,

ALBERT A. GARDNER,
Collector.

C 3.

IMPROVEMENT OF HARBOR OF WOOD'S HOLL, MASSACHUSETTS.

This harbor is on the north side of Vineyard Sound, and is divided into Great Harbor and Little Harbor. The name "Wood's Holl" is also applied to the adjoining strait which connects Vineyard Sound with Buzzard's Bay. The site of the works now under construction is Great Harbor, Wood's Holl. The rise and fall of the tide is about 2 feet.

ORIGINAL CONDITION.

Before improvement, the site of the present works was a submerged point of land extending from the shore of the harbor.

PLANS OF IMPROVEMENT.

The adopted project for the improvement of Great Harbor, Wood's Holl, was for the construction of retaining-walls on the shore, a hollow pier and wharves for the use of the United States Fish Commission, and to serve also as a coaling station for vessels of the Revenue Marine and other branches of the public service, and as a harbor of refuge. A plan of the works may be found in the Report of the Chief of Engineers for 1884, Vol. I, page 598.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended on these works to June 30, 1885, including liabilities outstanding at that date, was $77,842.66 The retaining and pier walls and the dredging of the interior of the hollow pier and the berths for public vessels had been completed, and the coal, the west, and the cross wharves had been essentially completed.

OPERATIONS DURING THE LAST FISCAL YEAR.

For want of funds no work has been in progress during the last fiscal year.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work required for the completion of the project for the improvement of Great Harbor, Wood's Holl, is the construction of the south and east wharves. In the strait of Wood's Holl there is a large and dangerous rock which is to be removed.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the construction of the south and east wharves, and the removal of the dangerous rock in the strait of Wood's Holl, just referred to.

Wood's Holl is in the Barnstable collection district. New Bedford is the nearest port of entry. The amount of revenue collected in the last fiscal year was at Barnstable $1,670.92, and at New Bedford $48,361.08. The nearest light-house is Nobsa Light; the nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1885, amount available	$64 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	17 05
July 1, 1886, amount available	46 95
Amount appropriated by act approved August 5, 1886	14,500 00
Amount available for fiscal year ending June 30, 1887	14,546 95

COMMERCIAL STATISTICS.

PACIFIC GUANO COMPANY,
Wood's Holl, Mass, June 30, 1886.

DEAR SIR: In reply to your favor of the 17th instant, we send the following statement in regard to the commerce and navigation of this place.

There have been received during the past year—

Articles.	Quantity.	No. of cargoes.
Coal	6,500 tons	[illegible]
Barrels	1,300 barrels	[illegible]
Lumber	563,000 feet	4
Hay, lime, brick, spiles, and wharf material		[illegible]

and there have been received and shipped 128 cargoes phosphate rock, brimstone, nitrate of soda, fish scrap, and other fertilizing materials and completed fertilizers, aggregating 49,000 tons, in sailing vessels of from 100 to 1,200 tons, and one foreign steamer of 2,600 tons.

There have also been shipped 3,000 barrels of fish and other general merchandise and produce by lines of steamers to New Bedford, Martha's Vineyard, and Nantucket, besides all the materials and supplies which Martha's Vineyard and Nantucket receive from the interior via the Old Colony Railroad.

Our harbors are in constant use throughout the year by fishing vessels, yachts, coasters, and wrecking steamers as a harbor of refuge.

Yours, truly,

ASA SHIVERICK.

Lieut. Col. GEORGE ELLIOT.

C 4.

IMPROVEMENT OF WESTPORT HARBOR, MASSACHUSETTS.

Westport Harbor is an estuary of a bay lying between Narragansett Bay, Rhode Island, and Buzzard's Bay, Massachusetts. This is a new work, and no appropriation had been made for it until, by act approved August 5, 1886, Congress appropriated $1,000 "for sand-fence." The late General Warren, then in charge of this district, in reporting, December 12, 1878, on the survey which he had made in accordance with section 2 of the act of June 18, 1878, stated that "the wearing of Horse Neck Point (on the north side of the entrance) could be prevented by small sand-catch jetties, and these could be gradually prolonged so as to narrow the space opposite and increase the average depth" (of the channel); and named $1,000 as the amount that could reasonably be expended in this way. It is supposed, therefore, that the $1,000 appropriated by the act of August 5, 1886, are intended for the construction of the sand-catch jetties recommended by the late General Warren, and the funds will be expended accordingly.

Money statement.

Amount appropriated by act approved August 5, 1886	$1,000 00

C 5.

IMPROVEMENT OF WAREHAM HARBOR, MASSACHUSETTS.

This harbor is an estuary at the head of Buzzard's Bay. The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham; the industries of which and of several towns in the vicinity with which it is connected by rail are chiefly the manufactures of iron, and depend largely on transportation by water of the material used therein. The commerce of Wareham is carried on in sailing vessels, and the channel is to be made a beating channel for such vessels. Another object of the improvement is in the raising of Long Beach, over which the sands from the bay were washed into the harbor. The mean rise and fall of the tide is 4 feet.

ORIGINAL CONDITION.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water in a narrow and very crooked channel. Long Beach, a narrow sand-spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

PLANS OF IMPROVEMENT.

The original approved project of 1871 for the improvement, and its subsequent modifications, provides for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet, with the same depth—10 feet—as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there, in order to prevent the filling of the improved channel above by material abraded from the beach.

A plat of Wareham Harbor, showing the lines of the channel now being excavated, may be found in the Annual Report of the Chief of Engineers for 1885, Vol. I, page 586.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $56,467.43, and the result was a channel through and above the upper bar to the wharves with a width of not less than 100 feet and a depth of 10 feet at mean low water. A large part of the work on the lower reaches of the channel had been done and the river opposite the wharves had been deepened to 9 feet below mean low water. Long Beach was raised above high-water storm-tides, except in a few places, so that the major part of the wash of sand into the improved channel inside the beach had been stopped.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of dredging the channel was in progress under the contract with the Atlantic Dredging Company, of Brooklyn, N. Y., which was described in the last annual report. It continued to August 5, 1885, when the contract was completed. The amount of material removed from the beginning of the fiscal year was 43,444 cubic yards of dredged material and 2.24 cubic yards of bowlders, all of which was carried to the dumping-ground between Abiel's Ledge and Dry Ledge, in Buzzard's Bay. New bounds were placed to mark the channel-lines of the entire improvement, and small repairs were made during the year to the stone and brush protective works at Long Beach damaged by the storms of the winter of 1885–'86.

The lumber of the old sand-catch fence at Long Beach, destroyed in the great storm of January 9, was sold at auction March 31, after due advertisement, and the proceeds were deposited in the Treasury.

Mr. Thomas A. Churbuck was local inspector of the work.

AMOUNT EXPENDED DURING LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1886.

The amount expended during the last fiscal year was $8,485.21. The channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and about one-half of the first reach below the wharves was excavated to its full depth of 10 feet below mean low water. This reach includes the heaviest cutting in the entire improvement. The ruling depth of the approaches to Wareham has now been increased from 7 to 9 feet, and the channel has been greatly widened in all the reaches, especially in the main reach below the wharves. Vessels of larger draught can be carried to Wareham than formerly, and the increase in width of channel is already a great help to all vessels in beating in and out of the harbor.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the excavation of the channel to its full width and depth from the point to which it was carried by the last contract down to the deep water above Long Beach. There will also be required the expenditure of a few hundred dollars more in the further building up of Long Beach.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to carrying on the work according to the approved project as far as the funds will admit.

Wareham is in the New Bedford collection district. New Bedford is the nearest port of entry. The amount of revenue collected in the last fiscal year was $48,381.66. The nearest light-houses are Bird's Island and Wing's Neck lights. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1885, amount available	$8,532 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,485 21
July 1, 1886, amount available	47 46
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,047 46

Amount (estimated) required for completion of existing project	$4,050 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,050 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

WAREHAM, MASS., *July* 10, 1886.

SIR: Replying to your inquiry referring to the commercial statistics of Wareham Harbor, I have the honor to write that I learn of no such changes in its commerce since the date of my advices to you in that respect of last year as will materially alter the carefully prepared statements that appear in your official reports for 1884 and 1885 upon the improvement of this harbor. An increase of commerce in some staple articles is apparent here, but it is not an equivalent for the decrease incident to the general depression in the manufacture of iron commodities. The commerce of this port has plainly been stimulated by the intended improvements in its navigation, but the benefits and great utility of these improvements cannot be realized fully until the completion of the work throughout as projected.

Very respectfully,

GERARD C. TOBEY.

GEORGE H. ELLIOT,
Lieut. Col. of Engineers, U. S. A.

C 6.

IMPROVEMENT OF TAUNTON RIVER, MASSACHUSETTS.

This river rises in Norfolk County, Massachusetts, and empties into Mount Hope Bay, a name given to that part of Narragansett Bay lying mainly in Massachusetts. It is about 44 miles in length, measured along its course.

The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quantities of coal, iron, clay, moldings, sand, and other heavy articles for its extensive manufactures, dependent largely on water transportation, so that vessels of 11 feet draught can reach the city at high water. The rise and fall of the tide before improvement was 5½ feet at Dighton and 3.4 feet at Taunton.

ORIGINAL CONDITION.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

PLANS OF IMPROVEMENT.

The approved project of 1871 and its subsequent modifications provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to the ship-yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to and through the Needles and Briggs's Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crosses the bottom of the river at Peter's Point, and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton were to be removed.

A plat of the river, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1884, page 606.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $134,470.44.

With the exception that but 40 feet of the 60 feet of width could only be dredged between the bridge at Weir and the ship-yard on account of interfering with private property, and that on account of the hardness and depth of the material at the sides the 80-foot channel was not, in all cases, dredged to its full width, the channel down to Berkley Bridge had been completed.

The major part of dredging below the bridge had been done, but this part of the channel still lacked in width at some places. The channel had been cleared of bowlders from Taunton down to Berkley Bridge. The work of uncovering the ledge at Peter's Point preparatory to its removal had been commenced.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year work was in progress under a contract with J. H. Fenner, of Jersey City, N. J., described in the last Annual Report, for cutting a channel 12 feet deep and 100 feet wide through the ledge at Peter's Point, and excavating by dredging a channel of the same dimensions between the upper part of "The Nook" and Dighton. The work of uncovering the ledge at Peter's Point by removing the overlying bowlders and gravel was completed in August, 1885, when a very careful survey was made to determine the cubic contents of the prism of rock to be excavated, to serve as a basis for payment to the contractor when the ledge work should be completed. The blasting and removal of the ledge was then commenced, and has continued until the end of the fiscal year with the exception of a suspension during the winter on account of ice, and other suspensions by reason of damages to the contractor's plant. The major part of the material blasted in the eastern half of the channel has been dredged, and deposited in the form of a half-tide dam running from Reuben's Island to the west shore of the river, with the view of accelerating the current in the dredged channel off and above Dighton and preventing deposits in this part of the channel. During the year surveys were made of the channel between Church's Wharf and Berkley Bridge, of Pioneer Rock and the shoal at the mouth of Three-mile River, and examinations were made of the channel at "Burt's Turn" and between North Dighton and Weir. The contract with Mr. Fenner has been extended, with the approval of the Chief of Engineers, to September 1, 1886. Mr. C. O. Abell was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR, AND RESULTS TO JUNE 30, 1886.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $2,917.95. All of the bowlders and gravel overlying the ledge at Peter's Point within the lines of the proposed channel have been removed; the work of blasting the ledge has been nearly completed; the major part of the broken rock has been removed by dredging, and the half-tide dam between Reuben's Island and the west shore of the river has been essentially completed. The ruling depth of water in the river has been increased from 5 to 11 feet at mean high water, and vessels of 11 feet draught can now reach Taunton, at the head of navigation.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

There remains to be done to complete the existing project the completion of the removal of the ledge at Peter's Point; the completion of the dredging of the channel between Berkley Bridge and Dighton, and widening and deepening at a few points above the bridge, for all of which it is hoped the funds now available will be sufficient.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the remainder on hand July 1, 1886, to the completion of the removal of the ledge at Peter's Point, and to the enlargement by dredging of the remainder of the channel between Dighton and Berkley Bridge as well as above the bridge.

Taunton River is in the Fall River collection district. Fall River is the nearest port of entry. The amount of revenue collected in the last fiscal year was $16,645. The nearest light-house is the Borden Flat light-house. The nearest fortification is Fort Adams, Newport Harbor, Rhode Island.

Money statement.

July 1, 1885, amount available		$22,529 56
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,130 46	
July 1, 1886, outstanding liabilities	787 49	
		2,917 95
July 1, 1886, amount available		19,611 61

COMMERCIAL STATISTICS.

TAUNTON, *July* 10, 1886.

DEAR SIR: In reply to yours of the 9th we will inclose to you the following commercial statistics:

Articles.	Quantity.	Articles.	Quantity.
Lumber .... feet..	11,000,000	Metals of all kinds .... tons..	39,000
Grain .... bushels..	1,238,000	Cotton .... bales..	25,500
Flour .... barrels..	40,000	Molding-sand .... tons..	22,000
Coal .... tons..	240,000	Clay .... tons..	28,000
All other kinds of merchandise.. tons..	20,000		

There are owned in Taunton forty-four schooners, whose total carrying capacity is nearly 35,000 tons. There are also belonging to Taunton nine coal barges with a total carrying capacity of 10,000 tons. A large part of the above vessels and all the barges go to Taunton with a part and in many cases with a full cargo. In addition to this there are four large boats constantly employed on the river and one or two pleasure boats and barges.

The population of Taunton has increased about 1,200 in the last year, and the business on the river is constantly increasing.

In addition to the above allow us to say that previous to February of the current year the channel which has been deepened and widened since the commencement of the last improvement on the river, has not filled in to any extent. In February last this section of country was visited by a terrible flood, being the most severe of anything of the kind for at least one hundred years. After the flood went down, it was found that in many places (one in particular a short way below Weir Village) the channel had been filled in 2 or 3 feet. We hope these shoals may be removed as quickly as possible and that the channel in the bends of the river may be widened.

Yours, truly,

STAPLES & PHILLIPS.

Col. GEO. H. ELLIOT.

C 7.

IMPROVEMENT OF PAWTUCKET RIVER, RHODE ISLAND.

The navigable part of the Pawtucket (or Seekonk) River, an arm of Providence River, extends from Providence to Pawtucket, a city which has a population of about 23,000, and extensive manufactures, depending largely on water transportation. The object of the improvement is to widen and deepen the channel leading to Pawtucket, so that vessels of 12 feet draught can reach that city at mean low water. The mean rise and fall of the tide is about 5 feet.

ORIGINAL CONDITION.

Before improvement, the channel in the river had a ruling depth of about 5 feet at mean low water.

PLANS OF IMPROVEMENT.

The original project as modified in 1883 provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Co.'s Wharf at Pawtucket; thence, the deepening by blasting of the channel through the ledge to Pawtucket Bridge to the same depth and 40 feet wide.

A plat of the river showing the lines of the proposed channel was published in the Annual Report of the Chief of Engineers for 1884, page 608.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended to June 30, 1885, was $52,718.44. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water. A contract had been made for deepening and widening this channel according to the modified plan of 1883, but the work had not been commenced.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. A contract, described in the last Annual Report, had been made in October, 1884, with Elijah Brainard and Thomas H. Benton, of New York, for dredging a channel 12 feet deep and 100 feet wide from the deep water just above Red Bridge as far towards the city of Pawtucket as the available funds would pay for, but the work was not to be commenced until the old Washington Bridge across the river near its mouth, which formed such an obstruction to navigation as would interfere with the passage of tows of the dredged material, should be removed. This delayed the commencement of the work till August 7, 1885, from which time it was continued until December 7, when the work was suspended for the winter by ice, and it was resumed on April 9, 1886. The time of completion of the contract was extended by authority of the Chief of Engineers to June 7, 1886. It was completed May 28, 1886, 212,734.57 cubic yards of material having been removed during the fiscal year. In November, 1885, a series of observations of the rise and fall of the tide at Pawtucket was made for future determinations of the effect of the enlargement of the water-way on the tides at that place. Mr. John S. Engs, jr., was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR, AND RESULTS TO JUNE 30, 1886.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1886, was $49,241.02. The new channel, 12 feet deep and 100 feet wide with wide enlargements at the bends, has been carried from its mouth at the deep water just above Red Bridge, a distance of about 8,740 feet, or to a point about 1,000 feet above a line drawn from Bucklin Island to Swan Point Wharf.

This completed portion of the channel is already a great benefit to the commerce of the river and gives much satisfaction. A ruling depth of about 6 feet can be carried from the upper end of our present work to Pawtucket.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work yet to be done is to excavate by dredging the channel 12 feet deep and 100 feet wide from the point to which the last contract carried it to a point opposite Grant & Company's Wharf, and from thence to Pawtucket Bridge to deepen the channel through the ledge to the same depth with a width of 40 feet.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the excavation by dredging of the upper reaches of the new channel, and, if the funds will admit, to the commencement of the work on the ledge which lies in the channel off Pawtucket.

Pawtucket is in the collection district of Providence, and that port is the nearest port of entry. The amount of revenue collected at Providence in the last fiscal year was $180,933. The nearest light-house is Sassafras Point Light. The nearest fortifications are Fort Adams, Newport, Rhode Island, and the fort on Dutch Island, Rhode Island.

Money statement.

July 1, 1885, amount available		$49,287 52
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$49,217 27	
July 1, 1886, outstanding liabilities	23 75	
		49,241 02
July 1, 1886, amount available		46 50
Amount appropriated by act approved August 5, 1886		30,000 00
Amount available for fiscal year ending June 30, 1887		30,046 50

Amount (estimated) required for completion of existing project	$302,478 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	75,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

ER CIAL STATISTICS.

PAWTUCKET BUSINESS MEN'S ASSOCIATION,
Pawtucket, July 20, 1886.

DEAR SIR: Your letter of the 17th ultimo to the President of this association in relation to improvements of Pawtucket River was received in due time. In his absence I will simply state the statistics collected by the committee from this association in 1883 were substantially accurate, and correct for the last year if about 10 per cent. be added to the same.

Yours, very respectfully,

A. K. GOODWIN,
Vice President Pawtucket Business Men's Association.

Lieut. Col. GEORGE H. ELLIOT,
Corps of Engineers, U. S. A.

COMMUNICATIONS FROM THE PAWTUCKET, R. I., BUSINESS MEN'S ASSOCIATION.

1.

PAWTUCKET, R. I., *June 14, 1883.*

DEAR SIR: Your favor of May 22, addressed to the Pawtucket Business Men's Association, was duly received, and the undersigned, a committee appointed by said association to obtain the information desired, most respectfully submit the following statistics of the commerce in Pawtucket River for the year 1882:

IMPORTS.

Articles.	Quantity.	Articles.	Quantity.
Coal ....tons.	86,000	Ammonia water ....barrels.	210,000
Iron ....do..	5,300	Lime ....do..	2,500
Gravel ....do..	300	Cement ....do..	15,000
Clay ....do..	50	Long lumber ....feet.	9,000,000
North River stone ....do..	500	Short lumber, as shingles, laths, clapboards, &c..	3,000,000
Paving-stone ....do..	240	Spool lumber (about) ....feet..	2,000,000
Brick	2,000,000		

The above merchandise was received chiefly by barges and sailing vessels carrying from 150 to 600 tons each, and drawing from 7½ to 11 feet of water.

The number of water-craft passed through the draw-bridges for the year 1882 was as follows:

Class.	Number.
Steamboats	462
Tow-boats	766
Sailing vessels	413
Sail-boats	268
Miscellaneous	456
Total	2,281

We would call attention to the fact that the commerce upon the river is steadily increasing; also that extensive manufacturing establishments are now being erected upon the banks of the river, which will greatly increase the commerce upon the same, and in order to meet the demand for transportation in large barges and sailing vessels increased facilities to navigate the Pawtucket River should be made by widening and deepening the channel and removing the obstructions.

We wish especially to call attention to an obstruction known as Seal Rock, lying nearly in the middle of the channel of the river at the head of navigation, and we hope that such recommendation will be made as will cause its removal.

All of which is most respectfully submitted.

GEO. F. NEWELL,
GEO. P. GRANT,
HENRY E. JENKS,
Committee.

GEORGE H. ELLIOT,
Lieut. Col. of Engineers, U. S. A.

2.

PAWTUCKET, *August* 2, 1883.

DEAR SIR: We, the undersigned committee, beg leave to submit the following supplemental report in accordance with your request to furnish additional information respecting the commerce and manufactures that would be benefited by further improvement of the Pawtucket River.

Pawtucket, situated at the head of navigation, 4 miles above Providence, becomes a distributing point for merchandise to supply an extensive inland trade. Among the towns which draw more or less of their supplies from Pawtucket may be mentioned East Providence, Seekonk, Rehoboth, Attleboro', Mansfield, Wrentham, Franklin, Cumberland, Lincoln, Smithfield, and North Providence.

Pawtucket naturally commands the trade of the territory for half the distance to Boston and entire valley of the Blackstone River. One hundred and thirty trains over Boston and Providence, the Providence and Worcester, and the New York and New England Railroads pass through this place daily. Its convenience for transportation by rail, the facility with which its citizens can reach all the large centers of business, together with its manufacturing and mechanical industries, have attracted people from various parts of the world to settle here.

The growth of Pawtucket has been rapidly increasing. In 1865 there were 5,000 inhabitants; at the present time, 1883, there are between 23,000 and 25,000. If we include the immediate villages of Central Falls, Valley Falls, Lonsdale, and Saylesville, we may safely say we have a population of upward of 35,000.

Within these limits there is a great variety and a vast amount of manufacturing and mechanical industries carried on, and from which the General Government has in years past received large revenues. They paid during the fiscal year ending June 30, 1866, $636,691.98 into the office of the assessors for internal revenue for the first district of Rhode Island.

The revenue from the Pawtucket post-office for the fiscal year ending December 31, 1882, was $12,298.28, which will give you some idea of the business which is transacted here at the present time.

Pawtucket is largely a manufacturing community, and in the extent and variety of its manufactures is not surpassed by any place of equal size in the United States. It contains some of the largest establishments of their kind which are to be found in the country, among which may be mentioned the Conant Thread Company, manufacturers of the J. & P. Coats spool cotton, with a capital of $3,000,000, and employing over 2,000 operatives, and consuming in the single item of coal 20,000 tons annually.

The W. F. & F. C. Sayles bleacheries, with their manufacturing establishments, employ over 1,500 hands, and their consumption of coal per annum is 15,000 tons.

The Rhode Island Horse Shoe Company, situated in Valley Falls, in the immediate vicinity of this place, is the largest of its kind in the world, and calls for a transportation of 150 tons per day, with a consumption of 12,000 tons of coal per annum.

Without entering further into detail, we would add that not less than $25,000,000 are invested in the different manufacturing industries, all of which could not fail of being benefited by the removal of the obstructions and the improvement of the channel of the Pawtucket River.

The specific improvements needed to put the river in proper condition are the removal of the obstructions at the Railroad and Washington bridges, the straightening, widening, and deepening of the channel, so that when completed it shall have a width of 150 to 200 feet and a depth of 12 feet at low water; also the removal of Seal Rock, near the head of navigation.

Provision has been made by the State government for the removal of the present Washington Bridge and the obstructions under the same, making a depth of water of not less than 15 feet at low water; also providing for five commissioners, to be appointed by the State, the town of East Providence, and the city of Providence, to execute the foregoing provision, build a bridge in the place of the present Washington Bridge, with a draw having two openings of 80 feet in width, and two years' time has been allowed the commissioners for the completion of the work. Commissioners have already been appointed by the State and the town of East Providence.

All of which is most respectfully submitted.

GEO. E. NEWELL,
GEO. P. GRANT,
HENRY F. JENKS,
Committtee of Pawtucket Business Men's Association.

GEORGE H. ELLIOT,
Lieut. Col. U. S. Engineers.

C 8.

IMPROVEMENT OF PROVIDENCE RIVER AND NARRAGANSET BAY, RHODE ISLAND.

Providence River is an estuary of Narragansett Bay. The object of its improvement is to furnish a wide and deep channel for European and coastwise commerce from the ocean to Providence, a city of about 125,000 inhabitants, largely engaged in manufactures, and a port of entry for an extensive region of country with which it is connected by railroads. The mean rise and fall of the tide is 4.7 feet.

ORIGINAL CONDITION.

Before the improvement of the river was commenced, in 1853, many shoals obstructed navigation and at one point in the channel—a place called "The Crook"—the available low-water depth was but 4½ feet.

PLANS OF IMPROVEMENT.

There was expended between 1852 and the 30th June, 1882, $290,459.34 in deepening the channel, first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low water.

The approved project of 1878, modified in 1882, under which we are now working, provides for a channel 25 feet deep and 300 feet wide, suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage-basin between Fox and Field's Points of the following dimension, in cross-section, viz:

300 feet wide, 25 feet deep.
600 feet wide, 20 feet deep.
725 feet wide, 18 feet deep.
940 feet wide, 12 feet deep.
1,060 feet wide, 6 feet deep.

The 25-foot channel has been laid out in straight reaches (with enlargements at the angles) with a view to lighting them by range or leading lights, such as are used in similar cases in Cheasapeake Bay, Delaware River, and other localities, if it should be found necessary.

A plat of Providence River, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1884, page 622.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $210,180.96. At that date about one-half of the excavation required for the anchorage-basin above Field's Point had been done. Bulkhead Rock had been removed and the condition of the six

straight reaches into which the 25-foot channel, 300 feet wide, is divided was as follows: The Fox Point, the Sassafras Point, the Field's Point, the Pomham and the Pawtuxet reaches had been completed, and the lowest, the Gaspee Reach, had been excavated to a width of 200 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

For want of funds no work has been in progress during the last fiscal year.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

To complete the 25-foot channel 300 feet wide, to the deep water of Narragansett Bay, there remains the increasing to 300 feet the 200 feet of width already excavated in the lowest (the Gaspee) reach. There also remains for the completion of the existing project the remainder of the excavation of the anchorage-basin between Fox and Field's Points.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the completion of the dredging required in the Gaspee Reach, and to continuing the excavation of the anchorage-basin above Field's Point.

Providence River is in the collection district of Providence, which is a port of entry. The amount of revenue collected in the last fiscal year was $180,933. The nearest light-houses are the six light-houses in Providence River. The nearest fortifications are fort on Dutch Island, and Fort Adams, Rhode Island.

Money statement.

July 1, 1885, amount available	$3,419 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	749 93
July 1, 1886, amount available	2,669 74
Amount appropriated by act approved August 5, 1886	30,000 00
Amount available for fiscal year ending June 30, 1887	32,669 74
Amount (estimated) required for completion of existing project	205,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

PROVIDENCE BOARD OF TRADE, SECRETARY'S OFFICE,
Providence, R. I., June 22, 1886.

DEAR SIR: In reply to yours of the 17th, I beg leave to make reply as follows:

The whole number of arrivals at this port from foreign countries during the year 1885 was 86, of which 27 only were American, bringing—

Articles.	Quantities.	Articles.	Quantities.
Lumber ....feet..	2,562,000	Logwood ....pounds..	5,841,000
Shingles	2,448,100	Brimstone ....tons..	680
Laths	6,868,000	Molasses ....gallons..	54,976
Pickets	38,000	Potatoes ....bushels..	12,102
Piling ....pieces..	14,200	Coffee ....pounds..	17,057
Wood ....cords..	1,866	Hides	184
Salt ....pounds..	8,293,269		

Amount of duties collected	$189,335 10
Amount of tonnage dues	348 45

There were also received—

Articles.	Quantities.	Mode of transportation.
Cotton .... bales..	245, 607	Water and rail.
Wool .... do....	180, 849	Do.
Flour .... barrels..	269, 277	Do.
Corn .... bushels..	1, 671, 580	Do.
Coal .... tons..	870, 147	Water.
Lumber .... feet..	37, 142, 208	Do.

TONNAGE.

Description.	No.	Tons.
Sail vessels	109	11, [illegible]
Steam vessels	38	24, 945. [illegible]

The above figures are as near as I can get them, and I have no means of separating the receipts by water and rail.

Yours, &c.,

F. P. LITTLE,
Secretary.

To Lieut. Col. GEORGE H. ELLIOT.

LETTER OF MR. GEORGE R. PHILLIPS.

PROVIDENCE, R. I., *June* 18, 1886.

DEAR SIR: Your favor of the 17th instant received, and contents noted. The foreign importations to the port of Providence for the year 1885 are as follows:

Articles.	Quantity.	Articles.	Quantity.
Lumber .... feet..	2, 562, 000	Logwood .... pounds..	5, 341, [illegible]
Laths .... do...	6, 686, 000	Brimstone .... tons..	[illegible]
Shingles	2, 431, 000	Molasses .... gallons..	54, 976
Pickets	38, 000	Potatoes .... bushels..	12, 102
Wood .... cords..	1, 866	Coffee .... pounds..	17, [illegible]
Piling .... pieces..	1, 420	Salt .... do ..	8, 298, [illegible]

The domestic importations were as follows, with some exceptions not reported:

Articles.	Quantity.	Articles.	Quantity.
Coal .... tons..	870, 147	Beef .... pounds..	21, 707, [illegible]
Cotton .... bales..	245, 607	Oil .... barrels..	[illegible]
Wool .... do...	180, 849	Liquors .... do....	106, 757
Flour .... barrels..	269, 277	Iron and steel .... pounds..	44, 316, [illegible]
Corn .... bushels..	1, 671, 580	Lumber .... feet..	37, 142, 208

There has been an increase in many of the importations over last year. It is to be hoped that the General Government will take some notice of the request of many of our citizens to have Green Jacket Shoal taken away. It is a great barrier to navigation, and the space could be used to advantage as anchorage-ground.

Very truly, yours,

GEORGE R. PHILLIPS.

GEORGE H. ELLIOT,
Lieutenant-Colonel of Engineers.

C 9.

REMOVAL OF GREEN JACKET SHOAL, PROVIDENCE RIVER, RHODE ISLAND.

Green Jacket Shoal is in that part of Providence River which constitutes the harbor of Providence. It lies off the wharves on the south front of the city, and occupies a part of the harbor that is required for anchorage purposes.

This is a new work, and no appropriation had been made for it until by the act of August 5, 1886, Congress authorized its commencement by making an appropriation of $26,250 therefor.

My report of January 10, 1885, of the survey of the shoal, the plat, and the estimate of the cost of the work ($112,346.25) on which the appropriation was founded, were published in the Annual Report of the Chief of Engineers for 1885, Vol. I, pages 598-602.

It is proposed, with the appropriation of August 5, 1886, to commence the work by removing that part of the shoal where additional anchorage is most required.

Green Jacket Shoal is in the collection district of Providence, which is a port of entry. The amount of revenue collected during the last fiscal year was $180,933. The nearest light-houses are the six light-houses in Providence River. The nearest fortifications are fort on Dutch Island and Fort Adams, Rhode Island.

COMMERCIAL STATISTICS.

For the commercial statistics, see report of the improvement of Providence River and Narragansett Bay, Rhode Island, Appendix.

Money statement.

Amount appropriated by act approved August 5, 1886	$26,250 00
Amount (estimated) required for completion of existing project	86,096 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

C 10.

IMPROVEMENT OF WARREN RIVER, RHODE ISLAND.

Warren River is an arm of Narragansett Bay north of the harbor of Bristol. This is a new work and no appropriation had been made for it until by act approved August 5, 1886, Congress appropriated $5,000 for the improvement of the river. In my report, January 12, 1885, of the survey made in accordance with the act of July 5, 1884, I stated that the obstructions to navigation were a rocky reef below Little Island, and a submerged bowlder near mid-channel opposite the lower wharf of the town of Warren, and recommended that this bowlder and the reef referred to be removed as far as it could be done with an expenditure of $5,000 for both purposes. They are doubtless the improvement appropriated for by act of August 5, 1886, and the funds will be expended accordingly.

A plat of Warren River was published in the Annual Report of the Chief of Engineers for 1885, Vol. I, page 630.

Money statement.

Amount appropriated by act approved August 5, 1886	$5,000 00

C 11.

IMPROVEMENT OF NEWPORT HARBOR, RHODE ISLAND.

This harbor is at the mouth of the main entrance to Narragansett Bay. These waters during summer and winter constitute a harbor of refuge for our European and coastwise commerce quite equal in every respect to that of New York Harbor, and are even more accessible. The objects of the improvement are to widen and deepen the southern (the main) entrance to the harbor, and to enlarge its capacity for vessels seeking refuge in storms, by increasing the area and depth of the anchorage within it. The mean rise and fall of the tide is about 3¾ feet.

ORIGINAL CONDITION.

Before improvement the capacity of the inner harbor was limited by shoals, and it was not adequate to the number and size of vessels seeking it for refuge. The southern (the main) entrance was obstructed by a bar which stretched out from Goat Island, and the general business wharves of the city could not be reached at low tide by vessels drawing more than 8 feet.

PLANS OF IMPROVEMENT.

The original project and its modifications under which we are now working are substantially as follows:

Deepening the southern entrance to 15 feet at mean low water, and widening it by dredging Goat Island Spit northward to a line drawn from the dolphin which marks the spit to clear the permanent dock at Fort Adams by 100 feet; the excavation of a channel 750 feet wide and 15 feet deep at mean low water around and to the eastward of this dolphin; excavating to 13 feet at mean low water the area included between the 13-foot curve on the west, a line drawn from the southwest corner of Perry Mill Wharf to Lime Rock on the south, the harbor-line on the east, and a line drawn parallel to and 50 feet from the City wharf, on the north; excavating to 10 feet at mean low water the area northwest of a line drawn from Lime Rock through the spindle which is in the southeast part of the harbor; the excavation of a channel 10 feet deep at mean low water along and outside the harbor line south to a point opposite the gas company's wharf, and the construction of jetties on the western shore of Goat Island to arrest the drift of littoral sand and gravel into the southern entrance.

A plat of Newport Harbor, showing the plans of the work, was published in the Annual Report of the Chief of Engineers for 1885, Vol. I, page 604.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $86,966.66, with the following results: Of the area to be dredged to 13 feet within the harbor, about two-thirds had been completed, except at a few places in the northern part of the harbor where the material was found too hard for the dredge in use at the time, and except that a bulkhead was left in the extreme northeast part of the harbor to protect an anchorage for small vessels. The channel along and outside the harbor line south to a point opposite the gas company's wharf and the 15-foot channel 750 feet wide around and to the eastward of the dolphin on Goat Island Spit had been completed. Of the 460 feet (about) of increase of width to be made between the 15-foot curves at the southern entrance by dredging the spit south of Goat Island, 224 feet had been gained.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of widening the southern entrance to the harbor by dredging Goat Island Spit to a depth of 15 feet at mean low water was in progress under a contract with the Hartford Dredging Company, of Hartford, Conn., which was described in the last Annual Report, and the time of completion of which was extended to October 1, 1885. The contract was completed September 8, 1885, and the amount of material removed during the fiscal year was 20,184.54 cubic yards. Mr. John S. Engs, jr., from July 1 to August 1, 1885, and Capt. B. F. Case, from August 1 to September 8, were local inspectors of the work.

Several bowlders were removed from the bed of the harbor, and the stone jetty on the southwest shore of Goat Island was raised and repaired in a very substantial manner and extended to a distance of 133 feet from the shore.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR, AND RESULTS TO JUNE 30, 1886.

The amount expended during the last fiscal year was $5,853.38, and the result was the further widening of the 15-foot depth at the southern entrance by 180 feet, or to within 56 feet of the proposed northern limit of this channel, viz, a line drawn from the dolphin which marks the Goat Island Spit to clear the permanent dock at Fort Adams by 100 feet, and the effectual stopping for the present of the supply of littoral sand and gravel from the outside of Goat Island into the southern entrance by the extension and raising of the jetty on the southwest shore of the island. When the northwest angle between this jetty and the shore has been filled and the sand and gravel commence to be washed around its end, another jetty further northward on this shore will be required, but this will probably not occur for many years to come. The southern entrance is completed with the exception of the small amount of work above mentioned, and it is now wide and safe for vessels of 15 feet draught. Of the total area to be deepened within the harbor (about 90 acres) about one half has been completed.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work required to be done to complete the existing project is the small remainder of the cutting away of the spit south of Goat Island to 15 feet depth, the remainder of the excavation within the harbor of the anchorage area of 13 feet depth, and the excavation, also within the harbor, of the anchorage area of 10 feet depth; also the building of additional jetties outside of Goat Island whenever they may be required to arrest the drift of littoral sand and gravel into the harbor entrance.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the completion of the deepening to 15 feet below mean low water of the spit south of Goat Island to the northern limit before stated; to the extension of the anchorage area within the harbor of 13 feet depth, and if the funds will allow, to the commencement of the extension, also within the harbor, of the anchorage area of 10 feet depth. It is also proposed to do a small amount of dredging at the end of the wharf at Fort Adams, at which supplies for the fort are landed.

Newport is in the collection district of Newport, and is a port of entry. The amount of revenue collected in the last fiscal year was $1,622.81. The nearest light-houses are Lime Rock and Newport (Goat Island) lights. The nearest fortification is Fort Adams, Newport, R. I.

Money statement.

July 1, 1885, amount available	$6,235 37
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	5,853 38
July 1, 1886, amount available	381 99
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,381 99
Amount (estimated) required for completion of existing project	52,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, NEWPORT, R. I.,
Collector's Office, July 13, 1886.

SIR: I have the honor to acknowledge the receipt of your letters of the 17th ultimo.

During the year ending June 30, 1886, about 5,000 vessels of all classes have arrived at this port, either for a harbor or to discharge cargoes; this includes steam and sail vessels engaged in the coasting trade, fisheries, and yachting.

During the year ending June 30, 1886, 11 vessels have arrived at this port from foreign ports and discharged their cargoes; 13 vessels have cleared from this port for foreign ports. The cargoes from foreign ports consisted of—

Articles.	Quantity.	Value.
Spruce boards ... feet	1,216,998	$12,827 31
Spruce laths ... pieces	115,700	1,707 72
Hemlock boards ... feet	20,349	142 44
Pine boards ... do	62,896	814 17
Shingles	461,000	876 25

During the same year there has been landed at this port, say:

Articles.	Quantity.	Articles.	Quantity.
Coal ... tons	48,000	Brick	4,500,000
Shingles	4,500,000	Lumber ... feet	11,500,000
Laths	9,000,000	Hay ... tons	1,000
Lime ... barrels	12,500	Grain ... bushels	350,000
Cement ... do	8,500		

The amount of revenue collected in this district from duties on imports, tonnage tax, inspection of steam vessels, and miscellaneous receipts during the year ending June 30, 1886, was $1,622.81, the decrease from previous years being on account of changes in the law abolishing certain fees, &c.

There are 128 vessels owned and hailing from this port, viz, 107 sail, 21 steam, the tonnage of which amounts to: Gross tonnage, 5,644$\frac{52}{100}$; net tonnage, 4,522$\frac{41}{100}$, showing an increase over that of year ending June 30, 1885, and which will be still further increased in a few weeks by the addition of the fine new schooner James C. Clifford, gross tonnage, 377$\frac{52}{100}$; net tonnage, 358$\frac{65}{100}$, which has just been built in Boston to hail from this port; and also by the addition of the new ferry-boat Conanicut, which has just been launched. The tonnage of the largest vessel is 708$\frac{69}{100}$ gross, 673$\frac{26}{100}$ net; that of the smallest vessel, 2$\frac{75}{100}$ gross, 2$\frac{17}{100}$ net. The largest vessel draws 13 feet when loaded. Trusting these statistics are sufficient for your purpose,

I remain, respectfully,

J. H. Cozzens,
Collector.

Lieut. Col. George H. Elliot.

LETTER OF THE SUPERVISOR OF THE OLD COLONY STEAMBOAT COMPANY.

Old Colony Steamboat Company, Fall River Line,
Newport, R. I., July 10, 1886.

Dear Sir: In reply to your inquiry of the 17th ult. am pleased to inform you that the steamers of this line carried between New York and Fall River, *via* Newport, 250,000 tons of merchandise and 255,000 passengers during the year ending May 31, 1886.

Yours truly,

George Peirce,
Supervisor.

Lieut. Col. George H. Elliot.

LETTER OF THE SUPERINTENDENT OF THE NEWPORT AND WICKFORD RAILROAD AND STEAMBOAT COMPANY.

Superintendent's Office,
Newport and Wickford Railroad and Steamboat Company,
Newport, R. I., July 20, 1886.

Sir: In reply to yours of yesterday I have to say that our business for the year 1885, as reported to our board of directors, was as follows:

Source of revenue.	Amount.
From 68,945 1-2 passengers	$50,684 47
From carrying United States mails	8,947 56
From freights (mainly local)	3,808 12
From Adams Express Company	1,425 82
Total for the year	64,865 97

Yours, truly,

Theo. Warren,
Superintendent.

Col. George H. Elliot.

C 12.

HARBOR OF REFUGE AT BLOCK ISLAND, RHODE ISLAND.

This island is a part of the State of Rhode Island. It is 14 miles east of Montauk Point, the eastern end of Long Island, and its nearest point is about 10 miles from the mainland. Besides the wants of the mackerel fishing fleet and the general coast navigation, the island is an important point on our shores for ocean navigation. It has a signal station, connected by submarine telegraph with the mainland. Vessels are passing the island at all times and on all sides of it, and its position renders it of national importance. The object of the improvement is to furnish a harbor of refuge for vessels engaged in foreign and coastwise commerce. The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before the construction of the present harbor of refuge Block Island had no harbor which afforded protection for decked vessels. The only ones used were open boats, which on the approach of storms were hauled up on the beach by oxen. The largest of these boats were of about 10 tons burden.

PLANS OF THE WORKS.

The original project and its subsequent modifications provided for a harbor of refuge on the eastern side of the island, consisting of an inner harbor or basin for small vessels and an exterior harbor for large ones. The basin was to be about 250 by 300 feet in area and inclosed, with the exception of an opening of 80 feet in width. The exterior harbor was to be formed by a riprap breakwater, which has been built. About 300 feet from the sea end of this breakwater, which is 1,900 feet long, a gap 200 feet long was left for the convenience of vessels. The present project contemplates the filling of this gap, which was found to let in too much sea in stormy weather. A plat of Block Island, showing the position of the harbor of refuge and a plan of the works, may be found in the Report of the Chief of Engineers for 1885, Vol. I, page 612–613.

On the 8th December, 1884, the Senate of the United States directed that report be made of the necessity and cost of enlarging the inner harbor of refuge. The report, which was accompanied by plans and an estimate of the cost ($46,189), was printed in Senate Ex. Doc. No. 27, Forty-eighth Congress, second session, and may also be found in the Report of the Chief of Engineers for 1885, Vol. I, page 610. The commencement of this work has been approved by Congress making an appropriation of $12,000 therefor in the act of August 5, 1886.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The total expenditure up to June 30, 1885, including liabilities outstanding at that date, was $318,925.09. The inner harbor and the main breakwater, built in prolongation of the eastern side of the inner harbor and extending 1,900 feet from the shore, were constructed in the years 1870 to 1879, inclusive. The utility of the work at once became apparent. In stormy weather the inner harbor, especially, was filled with fishermen and coasters, and it soon became necessary to increase its depth from 7 feet, to which it had been dredged in the first instance, to 9 feet at mean low water. In 1883 a strong jetty was built out from the cliff to the eastward of the inner harbor, and a masonry wall was constructed on the inside of the crib work forming the eastern side of the inner harbor. The major part of the sea which formerly came into the outer harbor through the gap in the main breakwater in easterly storms had, at the beginning of the last fiscal year, been stopped by the partial filling of the gap.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of filling the gap in the main breakwater was in progress under a contract with James

COMMERCIAL STATISTICS.

BLOCK ISLAND, R. I., *June* 30, 1886.

SIR: In accordance with your request of the 17th instant, relative to the furnishing you with amounts of merchandise received and exported from Block Island, and the amount of vessels making use of our harbors, &c., for the year ending December 31, 1885, would respectfully make the following report, which is based upon the best information obtainable, and which I think is not far from correct:

Amount of merchandise received and exported from Block Island during the year ending December 31, 1885.

Articles.	Quantity.
Coal received .... tons..	5,000
Iron received .... do...	200
Grain received .... bushels..	11,000
Lumber received .... feet..	3,500,000
General merchandise, not included in the above, shipped and received .... tons..	15,000

Arrival and departure of vessels.

Steamers, from 50 to 1,000 tons	1,850
Sailing vessels, from 10 to 200 tons, from 2 to 10 feet draught	112,000

These figures cover all vessels that make Block Island Bay Harbor.
All of which is respectfully submitted.

NICHOLAS BALL.

Lieut. Col. GEORGE H. ELLIOT,
Corps of Engineers, U. S. A.

C 13.

IMPROVEMENT OF LITTLE NARRAGANSETT BAY, RHODE ISLAND AND CONNECTICUT.

Little Narragansett Bay lies on the north side of the eastern entrance from the ocean into Long Island Sound; Pawcatuck River, upon which is situated the important commercial and manufacturing town of Westerly, R. I., empties into the eastern side of the bay, and has been improved by the United States. The object of the improvement of Little Narragansett Bay was to deepen the approach from Long Island Sound to Westerly.

The mean rise and fall of the tide is 2.63 feet.

ORIGINAL CONDITION.

The navigable draught of water through the bay before improvement was about 4½ feet at mean low water.

PLAN OF IMPROVEMENT.

The project of 1878 for the improvement of the bay provided for a channel 200 feet wide and 7½ feet deep at mean low water from the entrance to the bay to the mouth of the Pawcatuck, and the removal of the bowlders which then obstructed navigation and any others which the excavation of the channel might develop. Subsequently, it was determined to clear away some large bowlders which interfered with steamboat navigation between this channel and Watch Hill Landing. The estimated cost of the improvement was $51,000.

A plat of Little Narragansett Bay, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1879, page 314.

AMOUNT EXPENDED AND RESULTS.

The project was completed in the fiscal year 1883–'84. The main channel as projected was excavated to its full width and depth, and many bowlders were removed from the Watch Hill Channel. Vessels drawing 10 feet of water can now reach the mouth of the Pawcatuck River at high water, but the full benefit of the improvement cannot be utilized until further deepening of that river to enable vessels of the same draught to reach Westerly.

A report on the further improvement of the Pawcatuck was submitted September 19, 1884, in compliance with the river and harbor act of Congress of July 5, 1884, which was printed as House Ex. Doc. No. 183, Forty-eighth Congress, second session, and is also contained in the Report of the Chief of Engineers for 1885, Vol. 1, page 623.

The remainder of the last appropriation for Little Narragansett Bay is reserved for comparative surveys of Sandy Point, at the entrance to the bay, which seems to be affected by the construction of the breakwater in Stonington Harbor, and for range-marks on Pawcatuck Point to guide through the new channel. The total cost of the completed improvement was $35,856.96.

Little Narragansett Bay is in the collection district of Providence and Stonington, the dividing line passing through the bay. Providence and Stonington are the nearest ports of entry. The revenue collected in the last fiscal year was: Providence, $180,933; Stonington, $1,735.69. The nearest light-houses are the Stonington and Watch Hill lights. The nearest fortification is Fort Trumbull, New London, Conn.

Money statement.

July 1, 1885, amount available	$143 04
July 1, 1886, amount available	143 04

C 14.

HARBOR OF REFUGE AT STONINGTON, CONNECTICUT.

Stonington Harbor lies on the north side of the eastern entrance from the ocean into Long Island Sound, and the main object of the improvement is to furnish a harbor of refuge for vessels entering and leaving this entrance to the sound. The mean rise and fall of the tide is about 2¾ feet.

ORIGINAL CONDITION.

Originally it was an open bay, unprotected from southerly storms, and obstructed by a shoal having a low-water depth of but 6 feet at the shoalest part. This shoal nearly filled the inner harbor, and left but a narrow channel on either side of a depth insufficient to permit vessels of 12 feet draught to reach the upper wharves at low water.

PLANS OF THE WORK.

A short breakwater was constructed in the years 1828–'31, at a cost of $34,766.65 for the protection of the commerce of the town of Stonington. The enlarged project of 1871 for the improvement of Stonington Harbor and its subsequent modification, under which work is now carried on, embraced dredging in the upper harbor and the construction of two breakwaters in the outer harbor. One of these, the western, was to be built out from Wamphassuck Point, the southwestern limit of the harbor, and to extend about 2,000 feet; and the other, the eastern, was to extend from the vicinity of Bartlett's Reef to the Middle Ground. The western breakwater was completed in 1880, at a cost of $103,190. The amount expended in dredging in the upper harbor was about $45,000. The position of the western end of the eastern breakwater has not been determined, but it will probably be found necessary, in order to afford all the protection desired, to extend the breakwater at least until it intersects a range from Stonington Light to the middle of Wicopessit Island. It may then be found desirable to carry it still further, possibly to the range from Stonington Light to the eastern end of Fisher's Island.

A plat of this harbor, showing the position of the breakwaters, was published in the Annual Report of the Chief of Engineers for 1884, page 632.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended upon the eastern breakwater up to the close of the fiscal year ending June 30, 1885, including liabilities outstanding at that date, was $89,575 98, and its length at that date was 1,850 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

For want of funds no work has been in progress during the last fiscal year.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work required to be done is to finish the construction of the eastern breakwater. In case it be found that sufficient protection to the harbor of refuge has been afforded when the range from Stonington Light to the middle of Wicopessit Island is reached, which will probably be the case, the length of breakwater yet to be built is about 720 feet.

By reason of the great danger to the large passenger steamers of the Stonington Line (New York and Boston), which the western end of the breakwater now is, especially in foggy and thick weather, and will be until it is completed and a light-house and fog-signal are erected upon it, it is very desirable that the whole amount necessary to finish the breakwater be granted in one appropriation.

The completion of this work will afford a thoroughly protected anchorage for vessels drawing 18 feet of water, and a harbor of refuge for the immense commerce which daily passes between Long Island Sound and the eastward.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to devote the small remainder on hand July 1, 1886, and the appropriation made by the act of August 5, 1886, to the extension of the east breakwater as far as the funds will allow.

Stonington Harbor is in the Stonington collection district, and is a port of entry. The amount of revenue collected in the last fiscal year was $1,735.69. The principal value of the harbor is as a harbor of refuge. The nearest lights are Stonington Light and Latimer's Reef Light. The nearest fortification is Fort Trumbull, New London Harbor, Connecticut.

Money statement.

July 1, 1885, amount available	$424 02
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	123 70
July 1, 1886, amount available	300 32
Amount approprjated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	20,300 32
Amount (estimated) required for completion of existing project	33,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	33,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, STONINGTON, CONN.,
Collector's Office, July 1, 1886.

SIR: In reply to your favor of June 17, I herewith respectfully furnish commercial statistics for this port:

Number of vessels entering from foreign ports	6
Number of vessels cleared for foreign ports	6
Value of merchandise imported	$4,877 39
Value of merchandise exported	$100 00
Amount duties collected	$968 81
Miscellaneous	$766 88
Entrance and clearance steamers	650
Estimated value cargoes coastwise received	$34,900,000 00
Estimated value cargoes coastwise shipped	$33,100,000 00
Value product fisheries	$135,000 00
Number vessels seeking harbor for refuge	2,100
Number of vessels registered in district	105
Tonnage ....tons	6,448.15
Estimated tonnage of freight received and forwarded from wharf of Stonington Steamboat Company for year ending June 30, 1886..tons	600,000

Very respectfully,

H. N. TRUMBULL,
Collector.

George H. ELLIOT,
Lieutenant Colonel of Engineers, U. S. A.

C.15.

IMPROVEMENT OF PAWCATUCK RIVER, RHODE ISLAND AND CONNECTICUT.

The navigable part of Pawcatuck River extends from the important manufacturing town of Westerly to Little Narragansett Bay, into which it empties. The approach to the river is through Stonington outer harbor and Little Narragansett Bay, and the object of the improvement is to deepen the river channel to the depth to which the channel through the bay has been dredged by the United States, and also to widen it.

The mean rise and fall of the tide is $2\frac{6}{10}$ feet at the mouth of the river, and $2\frac{3}{10}$ feet at Westerly.

ORIGINAL CONDITION.

Before improvement the channel was crooked and obstructed by numerous shoals, on some of which there was but 1½ feet at mean low water.

PLANS OF IMPROVEMENT.

By means of appropriations made in the years 1871–'75, the river was improved by the United States by the excavation of a channel 5½ feet deep at mean low water and 75 feet wide below the wharves, and from 35 to 40 feet wide between the lower and the upper wharves. My report of a resurvey of the river made in compliance with the river and harbor act of July 5, 1884, which was accompanied by a plat and an estimate of cost ($38,637.50), and was published in the Report of the Chief of Engineers for 1885, Vol. I, pages 623–625, recommended the further widening of the channel to 100 feet below the wharves and by an additional width of two cuts of an ordinary dredging-machine, or about 40 feet, between the lower and the upper wharves; also the deepening of the entire channel to 8 feet at mean low water.

The commencement of this work has been approved by Congress making an appropriation of $12,000 therefor in the river and harbor act of August 5, 1886.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1885.

The amount expended on the original project was $50,000, and it was completed.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

It is proposed to commence the work of widening and deepening the channel according to the enlarged project at the deep water near Lottery, and to carry it as far towards Westerly as the funds will admit, and also to afford such relief as the commerce of the river may require at the shoalest places in advance of the main work.

Pawcatuck River is in the collection districts of Providence and Stonington, the dividing line passing through the river. Providence and Stonington are the nearest ports of entry. The revenue collected in the last fiscal year was: Providence, $180,-933; Stonington, $1,735.69. The nearest light-houses are the Stonington and Watch Hill lights. The nearest fortification is Fort Trumbull, New London, Conn.

Money statement.

Amount appropriated by act approved August 5, 1886	$12,000 00
Amount (estimated) required for completion of existing project	26,637 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	26,637 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

WESTERLY, R. I., *June* 28, 1886.

DEAR SIR; I inclose statement of commerce, &c., on our river, furnished me by Captain Greenman, a reliable gentleman. I regret that I have not time to put the matter in better shape.

Yours, respectfully,

CHARLES PERRIN,
Secretary Business Men's Association.

Colonel ELLIOT.

STATEMENT OF BUSINESS DONE ON THE PAWCATUCK RIVER DURING THE YEAR 1885.

Coal brought, all in sail vessels	tons..	18,373
Iron brought, all in sail vessels	do...	650
Grain	bushels..	44,400
Lumber	feet..	3,972,017
Bricks		351,000
Sand	tons..	695
Stone out of river	do...	4,575

Vessels towed and sailed in and out with full cargoes, 203, drawing from 5 to 7½ feet of water, which is the extreme draught, except at high spring tides. Thirty-one vessels arriving in Stonington with lumber, drawing from 8 to 11 feet, which cargoes had to be taken in scows to Westerly.

Passengers by steamer Westerly under my command, 4,050.

Steamer Sadie, running between Westerly and Watch Hill, making from two to four trips daily for three months.

Steamer Julia runs between Westerly and Norwich, one trip daily, for three months. The passengers I have no means of ascertaining the number.

WILLIAM GREENMAN.

C 16.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Wreck of iron steamship Perkiomen, sunk by collision in the Atlantic Ocean, off Cape Cod, July 16, 1885. By direction of the Department I made report on this wreck September 4, 1885. The legal notice to all persons interested that if the wreck should not be removed within thirty days it would be pronounced derelict and be removed by the United States was published in newspapers, and personal notice was also sent by mail to the several owners of the vessel and cargo. On the 21st September advertisements were issued for poposals to remove the wreck, and copies were also sent by mail to all wreckers and contractors for removing sunken vessels the addresses of whom could be discovered. The proposals received and the terms of the contract with Mr. William E. Chapman, of Brooklyn, N. Y., the lowest bidder, will be found in the appended table.

The preparatory work of placing mooring-buoys was commenced November 5, but the work of blasting the wreck was not begun until the 18th of the month. By reason of storms and high waves at the site of the wreck, which was on the edge of Nantucket Shoals, about 3 miles northeast from Pollock Rip light-ship, and of strong currents endangering the lives of the submarine divers, it was found that on an average but about one day in six was it practicable to carry on the work of blasting the wreck. After three extensions of ten, ten, and thirty days, respectively, the wreck was finally removed to the required depth of 35 feet below mean low water on the 13th of January, 1886.

The specifications for the contract required the contractor to save, during the removal of the wreck to the depth required, all parts of the wreck, her cargo, &c., that in the judgment of the inspector in charge of the work were valuable, and, considering the state of the weather and of the sea, could be saved. The winter of 1885–'86 was an exceptionally severe one off Cape Cod, and the weather proving so unfavorable for work at the site of the wreck, the judgment of the inspector under the circumstances was that nothing of value other than the two heavy anchors and a portion of the chain could be saved from the wreck during the time provided in the contract, except with the certainty of an unwarrantable delay in the removal of the wreck itself. When the full depth required by the contract had been attained the saving of the anchors and the portion of the chain judged recoverable not having been done, as directed, it was insisted on, and after waiting at Hyannis with steamer and appliances for the work for several days for suitable weather, the contractor asked permission to be relieved from the expense of further attempts at their recovery, and instead to be allowed to pay their estimated value by having it deducted from the contract price. This was approved by the Department, and $422.50, the estimated value of the anchors and the portion of the chain judged by the inspector to be recoverable, and $105, the expense to the United States for local superintendent, &c., from the time for completion of the work as provided in the contract until its actual completion, were deducted from the contract price. Mr. Hiram W. Phillips was local inspector for the removal of the wreck.

Amount of contract	$7,480 00
Amount paid to contractor	6,952 50
Surveys, salary of inspector, advertising, and other expenses connected with the wreck	766 67

Wreck of schooner Almon Bacon, sunk in the Atlantic Ocean, off Point Judith, R. I., November 5, 1885. By direction of the Department I made a report on this wreck on the 9th November, 1885. The thirty days' notice to all persons interested required by law was published under date of November 18, and personal notice was also sent by mail to the owners and underwriters. The masts were taken out of the vessel December 11, at the instance of the owners, by a wrecking schooner, assisted by the United States revenue cutter Dexter, and all danger to navigation was thereby removed.

Amount expended for advertising	$6 75

Wreck of schooners Mott Haven and Willie De Wolf, sunk by collision in the Atlantic Ocean, off the entrance to Narragansett Bay, December 25, 1885. By direction of the Department report was made of these wrecks December 29, but no action by the War Department became necessary. The Willie De Wolf drifted to the shore of Block Island at Clay Head, where it did not endanger passing vessels, and the masts of the Mott Haven were taken out at the instance of the owners by a wrecking schooner, assisted by the United States revenue cutter Dexter, on the 30th December, removing all danger to navigation.

Amount expended for telegrams	$0 99

In concluding this part of my annual report which refers to the removal of obstructions to navigation, I desire earnestly to invite attention to certain disadvantages to the interests of the United States in the present laws on the subject. Section 4 of the river and harbor act of June 14, 1880, reads as follows:

> Whenever hereafter the navigation of any river, lake, harbor, or bay, or other navigable water of the United States shall be obstructed or endangered by any sunken vessel or water-craft, it shall be the duty of the Secretary of War, upon satisfactory information thereof, to cause reasonable notice, of not less than thirty days, to be given, personally or by publication, at least once a week, in the newspaper published nearest the locality of such sunken vessel or craft, to all persons interested in such vessel or craft or in the cargo thereof, of the purpose of said Secretary, unless such vessel or craft shall be removed as soon thereafter as practicable by the parties interested therein, to cause the same to be removed. If such sunken vessel or craft and cargo shall not be removed by the parties interested therein as soon as practicable after the date of the giving of such notice by publication, or after such personal service

> of notice, as the case may be, such sunken vessel or craft shall be treated as abandoned and derelict, and the Secretary of War shall proceed to remove the same. Such sunken vessel or craft and cargo and all property therein when so removed shall, after reasonable notice of the time and place of sale, be sold to the highest bidder or bidders for cash, and the proceeds of such sales shall be deposited in the Treasury of the United States to the credit of a fund for the removal of such obstructions to navigation, under the direction of the Secretary of War, and to be paid out for that purpose on his requisition therefor. The provisions of this act shall apply to all such wrecks whether removed under this act or under any other act of Congress. Such sum of money as may be necessary to execute this section of this act is hereby appropriated, out of any money in the Treasury of the United States not otherwise appropriated, to be paid out on the requisition of the Secretary of War.

In the river and harbor act of August 2, 1882, it was provided—

> That the power and authority granted to the Secretary of War under and by virtue of section 4 of the act of Congress approved June 14, 1880, relating to wrecks and sunken vessels, be and the same are hereby enlarged so that the Secretary of War may, in his discretion, sell and dispose of any such sunken craft, vessel, or cargo, or property therein, before the raising or removal thereof, according to the same regulations that are in the same act prescribed for the sale of the same after the removal thereof; and all laws and parts of laws inconsistent herewith are hereby repealed

The first of the above acts provides for the removal of the wreck at the expense of the United States and its sale *after* removal, but by reason of the depth of water at the site of the wreck, it is often the case that only a portion of the wreck, perhaps the masts, or the masts and upper works, are dangerous to passing vessels, and it is not necessary, in order to provide for safe navigation, to remove the entire wreck. In other cases, after a wreck has laid submerged during the length of time the law requires before it can be considered abandoned by its owners and pronounced derelict, the wrecked property is not worth the expense of raising and saving it. This is by reason of the time required, and the cost of the vessels and machinery and the hire of submarine divers engaged in the business of wrecking.

These considerations, among others, doubtless led to the law of 1882, which authorizes the sale of the wreck *before* removal; but for the reason just mentioned, that the abandoned wreck is not worth the cost of removal (else it would not be left derelict by the owners), the removal must still, in some way, be at the expense of the United States.

It is possible that the latter law contemplated the combining in one contract both the removal and the sale of the wreck; that is, that the contractor for the removal should take the wreck, or what he can save of it, in part payment for his work; but it has been considered that neither of the laws referred to, or both together, warrant a departure from the general laws governing public contracts and sales. Under these laws the removal must be done by the lowest bidder and the sale must be made to the highest bidder, and the removal and the sale must be separately provided for. In other words, the law of 1882 not being practical, it has been decided that the removal of a wreck and the saving of what can be saved must be done under a separate contract, and that the sale of the saved property must be made *after* removal, as provided in the law of 1880.

Specifications for removing wrecks now require, therefore, that the contractor shall raise and save the entire wreck, or specified parts of the wreck, or, as it is often impossible to decide beforehand what can be saved, sometimes he is required to save all of the parts of the wreck that in the judgment of the United States inspector in charge of the removal of the wreck are valuable and (considering the state of the weather and of the sea at the time) can be saved.

But the uncertainties and delays in the work of removal of wrecks by efforts to save property, and the dangers and expenses attending the business of wrecking are so great, that any requirement, however slight, for saving property in the contract for removal of a wreck adds enormously to the cost of the removal and out of all proportion to the value of the property saved; and rather than to include in the contract any requirement to save anything whatever, it would often be cheaper and better for the public interests to contract simply to destroy the vessel by blasting it by dynamite or other explosives down to the required depth, leaving the débris scattered over the bottom of the sea.

Still there is in almost every wrecked and abandoned vessel something of value that can probably be saved—it may be only the masts and rigging or the anchors and chain—and the United States should in some way get the value of it, to offset in part and as much as possible the cost of removing the wreck.

What can be saved depends so much on the state of the weather and of the sea and on the judgment of how much of danger the vessels and other plant of the contractor and the lives of his divers and other workmen shall be subjected to at different stages of the removal of the wreck, that no one will buy what the winds and the waves may enable another person with diverse interests (the contractor for the removal of the danger to navigation) to raise and save.

It is evident, therefore, since it costs in many cases more than it comes to for the United States to save wrecked property for the purpose of selling it *after* removal, that the sale should be made *before* removal, as contemplated in the act of 1882, and that that law should be enlarged so that the contractor for the removal of the wreck, or so much of it as may be necessary, may be required to purchase beforehand whatever there may be of value that he can save without delaying the removal beyond the contract time. The difficulty in this case is to provide for competition for the purchase as well as for the removal.

This can only be done by providing in the specifications for the removal that whatever he can save shall belong to the contractor for the removal. The bidders for the removal would then reduce their competitive bids by the value of what can be saved, or rather by the value of what they think they can save, and the bidders for this kind of work (professional wreckers) are the best judges of what can be saved, and what its value when saved is likely to be.

It would not be safe, however, to vest the complete ownership in property saved under such a contract in the contractor until he had finally and completely removed all parts of the wreck that are above the depth required for safe navigation, depending on the locality of the wreck; and until the completion of his contract and the acceptance of his work he should be required to store the property as public property at some designated place on shore.

In consideration of the foregoing I beg leave to suggest that the following provision be inserted in the next river and harbor bill:

> The power and authority granted to the Secretary of War by section 4 of the act of Congress approved June 14, 1880, relating to wrecks and sunken vessels, enlarged by the act of August 2, 1882, are hereby further enlarged, so that in any case of the removal under contract, after due public notice, of any abandoned and derelict vessel, or portion of such vessel, obstructing any of the navigable waters of the United States, the conditions of such notice and contract may, if the public interests will be subserved thereby, include the stipulation that any parts of such vessel, her cargo, and other property therein, that he can save shall become the property of the con-

tractor: *Provided*, That the ownership of such saved parts shall not be vested in the contractor until he has fully completed the removal of the obstruction and all other duties under his contract according to the terms and conditions of the contract.

Abstract of proposals for removing wreck of steamship Perkiomen, received in response to advertisement dated September 21, 1885, *and opened at Engineer Office, United States Army, Newport, R. I., at* 12 *o'clock noon on Thursday, October* 23, 1885.

No.	Name and address of bidder.	Price.	Remarks.
1	William E. Chapman, Brooklyn, N. Y.	$7,480 00	Work to be commenced within ten days from signing of contract, and to be completed within forty days (not including Sundays) from day of commencement.
2	Adoniram Fairchild, West Stratford, Conn.	9,500 00	
3	Atlantic and Gulf Wrecking Company, Somers Point, N. J.	9,900 00	

With the approval of the Chief of Engineers, the contract was awarded to William E. Chapman, of Brooklyn, N. Y., the lowest bidder, at $7,480. Date of contract, November 4, 1885.

APPENDIX D.

MPROVEMENT OF CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT, AND OF RIVERS AND HARBORS ON LONG ISLAND SOUND, CONNECTICUT AND NEW YORK.

REPORT OF LIEUTENANT-COLONEL D. C. HOUSTON, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Connecticut River, Massachusetts and Connecticut.
2. Thames River, Connecticut.
3. New London Harbor, Connecticut.
4. Clinton Harbor, Connecticut.
5. New Haven Harbor, Connecticut.
6. Breakwater at New Haven, Connecticut.
7. Milford Harbor, Connecticut.
8. Housatonic River, Connecticut.
9. Bridgeport Harbor, Connecticut.
10. Black Rock Harbor, Connecticut.
11. Southport Harbor, Connecticut.
12. Norwalk Harbor, Connecticut.
13. Port Chester Harbor, New York.
14. New Rochelle Harbor, New York.
15. Echo Harbor, New Rochelle, New York.
16. Mamaroneck Harbor, New York.
17. Greenport Harbor, New York.
18. Port Jefferson Harbor, New York.
19. Flushing Bay, New York.
20. East Chester Creek, New York.

UNITED STATES ENGINEER OFFICE,
New York, July 30, 1886.

GENERAL: I have the honor to transmit herewith my annual reports upon river and harbor works in my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

D 1.

MPROVEMENT OF THE CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT.

This river rises in the northern part of New Hampshire, flows in a general southerly course between the States of New Hampshire and Vermont, crossing the States of Massachusetts and Connecticut, and empties into Long Island Sound at Saybrook Point, Connecticut. It is divided naturally into two parts, Hartford, at the head of navigation, being the point of division, and appropriations by Congress have always specified in which parts of the river the money was to be expended.

The divisions are as follows:

1. *Above Hartford, Connecticut.*—Embracing a length of about 66 miles, from Hartford, Conn., to Miller's Falls, Mass.

2. *Below Hartford, Connecticut.*—Embracing a length of about 50 miles, from Hartford to Long Island Sound.

(1) ABOVE HARTFORD, CONNECTICUT.

Miller's Falls, Mass., is at the head of possible navigation of the Connecticut River. From this point down to Holyoke, Mass., a distance of about 32 miles, the river is susceptible of improvement, but it cannot be used now on account of a dam and falls at Holyoke, which entirely obstruct navigation. The lockage required to lift boats from the lower to the upper levels at Holyoke is about 60 feet. From Holyoke, Mass., to Enfield Falls, Conn., a distance of 18 miles, there is a fair channel of 4 to 5 feet depth at low water, which could be made 8 feet deep. Enfield Falls, or Rapids, cover a stretch of river about 5 miles long, having a fall of about 32 feet at low water. The bed is rocky and very uneven, and the slope not uniform, but consisting of a succession of long, shallow reaches, separated by rapids. From the foot of Enfield Falls to Hartford, a distance of 11 miles, the river has a broad, sandy bed, with a depth of 3 to 4 feet at low water. Under a charter from the State of Connecticut, granted in May, 1824, the Connecticut River Company has constructed a canal with locks around Enfield Falls; the locks are 80 feet long, 18 feet wide, and 4½ feet deep. The canal is chiefly used for water-power; the company collects toll from vessels using it.

Following is a list of the places where work has been done by the United States, with distances above the wagon bridge at Hartford:

	Miles.
Barber's Landing	4
Farmington River	5
Strong's Island	6¼
Scantic River	7½

PROJECTS FOR IMPROVEMENT.

In 1871 a project was approved "for giving an increased depth to the channel by the construction of wing-dams and by dredging." All the work done in this part of the river has been done under this project; it consists of dredging at Barber's Landing, and constructing wing-dams at Barber's Landing, Farmington River, Strong's Island, and Scantic River, at different times from 1871 to 1881. In 1878 a project for constructing a larger canal around Enfield Falls was submitted, and modified in 1880. (See Annual Report of the Chief of Engineers for 1881, Part I, page 566.) It provides for a canal around Enfield Falls, on the east bank of the river, extending down to the mouth of the Hockanum River, opposite Hartford. The levels were to be 10 feet deep at low water and 120 feet wide at the water line; the locks to be 200 feet long, 55 feet wide, and 8 feet deep over the miter-sills at low water. The esitmated cost of this work was $1,322,805, but it was considered not advisable to begin construction with a less sum than $450,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The available funds were not sufficient to begin work under the project and nothing was done.

PRESENT CONDITION OF IMPROVEMENT.

It is reported that the current has cut behind one of the wing-dams at Farmington River; the other dams are in fair condition. The available depth from Hartford up to Scantic River, as far up as any improvement has been made, is about 3 feet at ordinary summer stage of the river.

PROPOSED OPERATIONS.

Such work as may be required for the repair and maintenance of the wing-dams and of the existing channel will be made with funds now available. No other work is contemplated, unless an appropriation sufficient to begin the canal around Enfield Falls is made; $450,000 would be required for this.

Appropriations for improving the Connecticut River above Hartford, Conn., have been made as follows, viz:

Date.	Application.	Amount.
July 11, 1870	Dams at Scantic River, Strong's Island, Farmington River, and Barber's Landing; dredging at Barber's Landing, and surveys.	$20,000
Mar. 3, 1871		20,000
June 10, 1872		25,000
Mar. 3, 1873		20,000
June 14, 1880		15,000
	Total	100,000

Of these amounts the following balances are yet unexpended:

From appropriation of June 10, 1872, for "improving the Connecticut River on or above Enfield Falls"	$10,702 92
From appropriation of June 14, 1880, for "improving the Connecticut River between Hartford and Holyoke"	13,410 80

COMMERCIAL STATISTICS.

The commerce of the river above Hartford is not large, on account of the impossibility of navigating it, except with very small boats. When the water is high a good deal of freight is sent this way which at other times goes by rail. Were the river improved as proposed, this traffic would be very large, as the greater part of the heavy freight used in and near the manufacturing towns of Springfield, Holyoke, Chicopee, and Miller's Falls would be brought by water.

Money statement.

July 1, 1885, amount available	$24,372 72
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	259 00
July 1, 1886, amount available	24,113 72

(2) BELOW HARTFORD, CONNECTICUT.

The Connecticut River below Hartford is a large stream, for the first 21 miles flowing in a winding course, for the most part through alluvial meadows, which are overflowed at high water, and which consist of a light sandy soil, easily undermined. For the remaining 29 miles, to Long Island Sound, at Saybrook Point, the course is straighter, the banks more permanent and generally harder.

A gauge has been established at Hartford, whose zero is the lowest stage that the water is known to have reached. The usual low-water stage of the river in summer is about 1 foot on this gauge. Spring freshets ordinarily rise to 20 feet; the highest recorded stage of water is 29 feet.

The average tide at Saybrook is 3½ feet; at Hartford it is about 1 foot, though when the river stands above 5 feet on the Hartford gauge the tide there is not perceptible. The slope of the river from Hartford to Saybrook averages .0458 feet per mile. The bed of the river, through the alluvial meadows, within 10 miles of Hartford, is constantly changing from the undermining of the banks; it is said that in places it has changed its position a half a mile within the memory of man. The bars in this part of the river, after being dredged, form again during spring freshets and ice-jams, so that some of them require annual dredging, others less frequently. This part of the river was improved by corporations and private parties at various times between 1800 and 1870; several small piers, to deepen the water in shoal places, were built in this way; some of these are now covered by new banks; the channel has shifted to the opposite side of some, and others have been dredged out, because they had come to be obstacles. The depth sought by these works was 6 feet at low water.

The following list gives the names of the several bars where work by the United States has been done, with their distance, by course of channel, below the Hartford Wagon Bridge.

Locality.	Miles.	Locality.	Miles.
Hartford Bar	1¼	Dividend Bar	13
Clay Banks Bar	2¼	Pistol Point Bar	15
Pratt's Ferry or Naubuc Bar	5¼	Mouse Island Bar	20½
Press Barn Bar	6¾	Chester Rock	28
Glastonbury Bar	9¼	Saybrook Bar (at mouth)	50

PROJECTS FOR IMPROVEMENT.

The first project for improvement by the United States was made in 1867; it proposed securing a channel 200 feet wide and 8 feet deep at low water, from Hartford to Long Island Sound, by dredging the bars, protecting the banks, and deepening the channel across Saybrook Bar, at an estimated cost of $64,310. Work was carried on under this project until 1879, the cost being largely increased by repeated dredging of the same bars, when an amended scheme was submitted by Lieut. Col. G. K. Warren, Corps of Engineers. (See Annual Report of Chief of Engineers for 1880, Part 1, pages 396–422.) This scheme contemplated securing a channel 200 feet wide and 9 feet deep at low water by means of riprap wing-dams, and mattress work on the concave banks, at a cost estimated as follows:

Hartford Bar	$33,4[illegible]
Clay Banks Bar	69,1[illegible]
Pratt's Ferry or Naubuc Bar	64,7[illegible]
Press Barn Bar	41,1[illegible]
Glastonbury Bar	114,9[illegible]
Dividend Bar	7,1[illegible]
Total	330,487

The estimate did not provide for improvement of Pistol Point and Mouse Island bars, where dredging has since been needed, nor for the extension of the Saybrook jetties and dredging between them, which has since been found necessary; nor did it include any amount for the annual dredging which has consumed a large part of the appropriations made since. It is evident, therefore, that the contemplated works could not be completed with the balance of the estimate.

Under this project, extended to include the necessary work at Saybrook by the close of the last fiscal year, a training wall of riprap 1,698 feet long had been built at Hartford Bar, and a wing-dam at Glastonbury Bar 5,300 feet long, both to 3 feet above low water; the east jetty at Saybrook had been extended to the 12-foot curve, and the west jetty nearly to the 16-foot curve, and a channel 120 feet wide and 12 feet deep at mean low water had been dredged between them, besides maintaining the required depth in the upper part of the river below Hartford, by annual dredging, at a cost of from $5,000 to $10,000 each year. One hundred and thirty-five thousand dollars have been appropriated for this part of the river since the project was approved, including $5,000 ordered by the appropriation act to be expended in dredging in Salmon River, a tributary 20 miles below Hartford. Of this amount only $73,000 have been applied to that part of the improvement provided for in the partial estimate of $330,487.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The west jetty at Saybrook was extended to the 16-foot curve—work done by hired labor under letter of authority from the Chief of Engineers, dated October 25, 1884; 1,542 tons of stone were delivered, building about 90 feet of the work. The total extension built under this authority is 320 feet, requiring 10,382 tons of stone, costing $1.16 per ton. A small gap in the west jetty was closed by the use of 40 additional tons of stone. Work was completed in September, 1885.

The dredging which was in progress at the beginning of the fiscal year, under an agreement with C. C. Goodrich, to dredge on the bars as required, at 10 cents per cubic yard, was completed July 15, 1885.

The amounts of material dredged during July were as follows:

	Cubic yards.
At Press Barn Bar	5,679
At Naubuc or Pratt's Ferry Bar	4,512
At Hartford Bar	3,863
Total	14,054

This, in addition to 34,135 cubic yards previously dredged, makes 48,189 cubic yards dredged under this agreement. The channels were all made 75 feet wide, with 9 feet clear depth at low water.

During the spring freshets of 1886 several of these shoals formed again, and under letter of authority from the Chief of Engineers, March 25, 1886, an agreement was entered into with C. C. Goodrich, of Hartford, dated April 2, 1886, to dredge about 10,000 cubic yards at the rate of 10 cents per yard. The entire amount, 10,000 cubic yards, was dredged from Hartford Bar between May 3 and May 20, making a channel 9 feet deep at mean low water and from 22 to 44 feet wide; work under this agreement stopped on account of exhaustion of funds. Mr. Goodrich has continued dredging at Hartford Bar and other bars without expense to, or authority from, the United States; it is understood that this work is done by Mr. Goodrich at the request of the Hartford and New York Transportation Company to make it possible for their boats to pass up and down the river.

PRESENT CONDITION OF IMPROVEMENT.

The training-walls, or wing-dams, at Hartford Bar and Glastonbury Bar have been built; the east jetty at Saybrook has been extended to the 12-foot curve, the west jetty to the 16 foot curve, and a channel 12 feet deep has been dredged between them. The dredging done by the United States and by the Transportation Company has, it is understood, made a narrow channel of 9 feet depth up to Hartford through the shoals formed by the spring freshets.

PROPOSED OPERATIONS.

The object of first importance under the existing project is the maintenance of the required depth of 9 feet by annual dredging, and future appropriations should be applied to that, unless they are made largely in excess of what is needed for such work. Experience with the wing-dams already built indicates that they will not maintain the channels without frequent dredging, and it seems advisable to postpone the construction of others at present. The appropriation estimated for the ensuing year is intended for dredging to maintain the required depth on the bars between Hartford and Middletown, at Haddam Island, and between the Saybrook jetties; for such repairs of the wing-dams already built as may become necessary, and for raising and reinforcing the east jetty at Saybrook.

Appropriations for the improvement of Connecticut River below Hartford, Conn., have been made as follows, viz:

Date.	Application.	Amount
March 2, 1867	Survey	Unknown.
July 11, 1870	Dredging at Mouse Island, Pistol Point, and Pratt's Ferry; piling at Hartford	$30,000
March 3, 1871	Dredging at Hartford, Claybanks, Pier I, Pier J, Pratt's Ferry, Glastonbury, Pistol Point, and Chester Rock	35,000
June 10, 1872	Dredging at Pistol Point and Pratt's Ferry: Saybrook jetty	40,000
March 3, 1873	Dredging at Hartford, Pratt's Ferry, and Glastonbury: Saybrook jetty	2[illegible],000
June 23, 1874	Dredging at Hartford, Pratt's Ferry, and Saybrook: Saybrook jetties	2[illegible],000
March 3, 1875	Dredging at Glastonbury, Hartford, and Pratt's Ferry: Saybrook jetties	2[illegible],000
Aug. 14, 1876	Dredging at Glastonbury, Hartford, and Pratt's Ferry: Saybrook jetties, Salmon River dredging	20,000
1878	Compensation for previous dredging	4,2[illegible]
June 18, 1878	Saybrook jetties, and survey from Hartford to Rocky Hill	30,000
March 3, 1879	Dredging Glastonbury, Hartford, and Press Barn	10,000
June 14, 1880	Dredging at Glastonbury, and Hartford; Saybrook jetties	10,000
March 3, 1881	Dredging at Glastonbury, Pratt's Ferry, and Hartford; Glastonbury pier, and Saybrook jetties	20,000
Aug. 2, 1882	Dredging at Glastonbury, Claybanks, Pratt's Ferry, Press Barn, Dividend, Pistol Point, Hartford, Salmon River, dredging; Hartford dike	45,000
July 5, 1884	Dredging at Hartford, Claybanks, Pratt's Ferry, Press Barn, Glastonbury, Dividend, Pistol Point, Mouse Island, and between jetties at Saybrook; extending west jetty at Saybrook	25,000
	Total	$339,2[illegible]

The Connecticut River is in the collection district of Middletown. By the course of the river the distance from Holyoke, Mass., to Hartford, Conn., is about 34 miles, and from Hartford to Long Island Sound about 50 miles. There is a light-house on Saybrook Point, on the west shore of the river, at its mouth, and another at the end of the west jetty.

Fort Trumbull, New London Harbor, Conn., about 16 miles east from Saybrook Point, is the nearest work of defense.

Money statement.

July 1, 1885, amount available	$5,813 51
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	5,813 51
Amount appropriated by act approved August 5, 1886	26,250 00
Amount (estimated) required for completion of existing project	169,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following information concerning the commerce of the Connecticut River below Hartford is furnished by the courtesy of the collector of customs at Middletown:

CUSTOM-HOUSE, MIDDLETOWN, CONN.,
Collector's Office, July 12, 1886.

SIR: The inclosed report, compiled from answers to inquiries and from the records of this office, is believed to be a fair exhibit of the commerce on the Connecticut River for the past fiscal year; but the collection of customs, though apparently related to it, has truly no connection with it, being derived almost wholly from the internal inland transportation business from New York and trade with Canada.

The report made this day to the Bureau of Navigation shows a total of 100 vessels and 14,000 tons gross tonnage. The river is important, not only to Connecticut, but to the States north of it, to which many of the products landed at Hartford are finally transported, and if the river were fully improved coal could be furnished to the towns in Massachusetts adjacent to the river at nearly $1 per ton less than at present.

Very respectfully,

GEO. W. BURKE,
Special Deputy.

Col. D. C. HOUSTON, U. S. A.

Summary statement of commerce on the Connecticut River, including port of Hartford and all below to mouth of river, in the district of Middletown.

For year ending June 30, 1886.	Number of vessels.	Tonnage.	Tons of 2,000 lbs. carried.	Estimated value of cargoes.
Entries, foreign sail	1	100	150	$1,200
Clearances, foreign sail	1	100	....	....
Entries, coastwise steamers	370	789,300	77,600	30,175,000
Clearances, coastwise steamers	370	789,300		
Entries } Coastwise, sail, and other craft	2,600	520,000	910,000	2,600,000
Clearances } Coastwise, sail, and other craft	2,600	520,000	390,000	1,300,000
Totals	5,942	2,618,800	1,377,750	34,076,200

Total amount of customs collected, $298,883.51.

Chief articles of commerce: Stone, coal, lumber; manufactures of cotton, wool, iron, britannia tin, &c.; grain, flour, feed, miscellaneous foreign goods.

About half of the above freight goes to and from Hartford; the other half belongs to the towns below.

D 2.

IMPROVEMENT OF THAMES RIVER, CONNECTICUT.

This river is formed by the confluence of the Yantic and Shetucket rivers at Norwich, Conn., and extends southward as a tidal stream 15 miles, to Long Island Sound. For 11 miles above its mouth the channel is from 16 to 80 feet deep, averaging over 30 feet for the first 4 miles.

For 3 miles below Norwich the available depth in 1829 was but 5 feet at low water, where now there is 10 feet depth. The work of improvement has been virtually confined to a stretch of 3½ miles below Norwich. Histories of the improvements may be found in the Annual Reports of the Chief of Engineers, 1873, page 981; and 1879, Part I, page 331.

PROJECTS FOR IMPROVEMENT.

The first definite project for improving this river was approved in 1836. It provided for a channel 100 feet wide and 14 feet deep at high water, to be obtained by dredging, by constructing eleven piers or wing-dams, and by adding to the three already built wings extending up and down stream, converting them into T-walls. The desired results were obtained, but shoals subsequently formed, and in 1866, and again in 1873, it became necessary to deepen and widen the channel by dredging. In 1878, after more shoaling, it was decided to make the channel 14 feet deep at low water instead of at high water, which would increase the depth 3 feet. This afforded only temporary relief; the shoaling continued, and in 1882 the project was further modified, under recommendation of Major Barlow, Corps of Engineers, approved by the Board of Engineers, by providing for the construction of five dikes or training walls along the outer sides of the channel curves, with the addition of low walls on the inner sides should they be found necessary, the width of water-way between them increasing from 300 feet at Thamesville, 1 mile below Norwich, to 480 feet at the lower wall. At the same time the projected width of the channel was increased to 200 feet. The improvement was to extend over the first 3½ miles below Norwich.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The dike on the east side of the channel at Long Rock, about 2 miles below Norwich, which was nearly completed in the previous year, was finished in July, 1885, 691 tons of riprap stone being delivered. Shoaling occurred along the line of the Long Rock Dike previous to its construction, so that the amount of stone required (11,945 tons) was much less than estimated (20,000 tons), and with the approval of the Chief of Engineers, work was begun on the Rolling Mill Dike, about 1½ miles below Norwich, by the contractor for the Long Rock Dike, Charles H. Edwards, of Boston, Mass., under an extension of his contract of October 15, 1884. Work was continued until October 24, 1885, when the contract was declared completed, 8,000 tons having been delivered in the Rolling Mill Dike, building 1,026 linear feet of the middle part of this dike to full dimensions, *i. e.*, 3 feet wide on top, the top at mean high-water level, and side slopes of 1 on 1; 105 tons of stone were also used in July, 1885, in partial repair of the Trading Cove Dike, which had settled.

The total amount of stone delivered under this contract was:

	Tons.
Long Rock Dike, complete	11,945
Trading Cove Dike, repairs	10
Rolling Mill Dike, beginning	8,0
Total	20,0

Of this amount 11,254 tons were delivered in the previous fiscal year. The material was riprap stone, partly granite, partly Connecticut River sandstone.

During May, 1886, an examination of the river near Norwich was made.

PRESENT CONDITION OF THE IMPROVEMENT.

Of the five dikes provided for in the project, the three furthest down-stream have been constructed at cost as follows:

Location of dike.	Date of completion.	Length of dike.	Number of tons of rip-rap.	Cost, exclusive of supervision, &c.
		Feet.		
Mohegan, 3½ miles below Norwich	1883	2,988	Pile-dike.	$23,686 00
Trading above, 2½ miles below Norwich	1882	2,370	17,207	21,113 05
Long Rock, 2 miles below Norwich	1885	2,800	11,945	12,781 15

The next in order, the Rolling Mill Dike, 1½ miles below Norwich, and planned to be 4,350 feet long, has been begun, 1,026 feet having been built, commencing at the south end of the old "sand pier," about the middle of the dike, and extending southward.

The upper dike, one-half mile below Norwich, planned to be 1,050 feet long, has not been begun.

The Mohegan Dike and the Trading Cove Dike need slight repairs, the former being crushed by ice at its upper end, the latter having settled.

The channel, which had an available depth of not less than 12 feet at mean low water for a width of 60 feet or over, has shoaled during the spring freshets, so that the available depth over the worst bars is from 9.5 to 11.5 feet.

PROPOSED OPERATIONS.

The funds now available are not sufficient to begin work with, but they will probably be enough to make such repairs as are needed at once. In order to secure the best attainable results the system of training-walls now in course of construction should be completed rapidly. One hundred thousand dollars can be profitably expended on this work and on the necessary dredging during the year ending June 30, 1888.

Appropriations for improvement of Thames River have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1821	Removal of obstructions placed during war of 1812	$150
Mar. 2, 1828	Survey	150
July 4, 1836	Piers and dredging	10,000
Mar. 3, 1837	......do	20,000
July 7, 1838	... do	10,000
June 23, 1866	Dredging and survey	10,000
Mar. 3, 1867	Dredging	72,000
Mar. 3, 1871	......do	15,000
June 10, 1872	......do	10,000
June 18, 1878	.....do	10,000
Mar. 3, 1879	do	12,000
June 14, 1880	Dredging and training-walls	22,500
Mar. 3, 1881	......do	30,000
Aug. 2, 1882	Training-walls	*35,000
July 5, 1884	......do	*25,000
	Total	281,800

* Appropriated for present project.

Thames River is in the collection district of New London. The nearest light-house is at the mouth of the river, on the west shore. Forts Trumbull and Griswold overlook the mouth of the river from either shore.

COMMERCIAL STATISTICS.

No record of arrivals and departures of vessels is kept, and it has been impracticable to obtain any statistics of the commerce of this river.

Norwich, at the head of the river, is a distributing point for coal and supplies to a large interior manufacturing district, principally along the line of the Norwich and Worcester Railroad.

A line of freight steamers makes trips nearly daily between Norwich and New York.

Money statement.

July 1, 1885, amount available		$17,252 30
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$12,499 95	
July 1, 1886, outstanding liabilities	64 04	
		12,563 99
July 1, 1886, amount available		4,688 31
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		27,188 31
Amount (estimated) required for completion of existing project		105,580 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

Abstract of contract for improving Thames River, Connecticut, in force during the fiscal year ending June 30, 1886.

Name and address of contractor.	Date.	Subject.	Price per ton.	Remark.
Charles H. Edwards, Boston, Mass.	Oct. 15, 1884	Delivery of riprap stone.	$1 07	Completed October 1885.

D 3.

IMPROVEMENT OF NEW LONDON HARBOR, CONNECTICUT.

New London Harbor is that part of the Thames River which lies in front of the city of New London, extending from Winthrop's Point to Long Island Sound, a distance of about 3 miles. It has good anchorage-ground, and a channel from 30 to 50 feet deep and a quarter of a mile wide extending up above Winthrop's Point. It is one of the best harbors on the Atlantic coast. No improvements of importance have ever been needed, and none were undertaken until 1880.

PROJECTS FOR IMPROVEMENT.

In 1878, shortly after the completion of the New London Northern Railroad Wharf, it was recommended that the United States undertake the removal, to a depth of 16 feet at mean low water, of a shoal of sand and bowlders lying east of this wharf, at an estimated cost of $6,800; when this project was adopted, under the appropriation of June 14, 1880, it was decided to limit the area of dredging to the southern part of the shoal; subsequently, in 1882, this was modified so that the dredged area should be that part of the shoal southwest of a line running south-southeast from a point 600 feet above the south end of the wharf. The depth in this part of the shoal varied from 6 to 15 feet.

In 1881, after the first work had been done, it was found that the material was much more difficult to handle than had been supposed, and a new estimate was made, increasing the cost to $24,000. Of this amount $17,800 have been appropriated; 20,360 cubic yards of sand and stones, and 519 cubic yards of bowlders have been removed. The original estimate provided for removal of 37,000 cubic yards of sand and gravel, and 125 cubic yards of bowlders; showing that the proportion of bowlders is much greater than was expected. These bowlders have ranged in size from one-fourth cubic yard to 5 cubic yards, and have frequently required blasting.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The available funds were not sufficient to begin operations with. An examination of the shoal was made in May, 1886.

PRESENT CONDITION OF IMPROVEMENT.

The required depth of 16 feet at mean low water has been made over nearly the whole area to be dredged, the part still requiring dredging being a wedge-shaped area about 50 feet wide and 200 feet long, lying southeast of the work already done. No work has been done within 75 feet of the wharf, improvement inside that limit being considered as of a private nature. The examination of May, 1886, showed that the dredged area has retained its depth.

PROPOSED OPERATIONS.

If the balance of the estimate ($6,200) be appropriated, it will be applied to the completion of the projected work on the shoal east of the railroad wharf, for which it will undoubtedly be sufficient. The work already done has made the east side of the wharf quite easy of access, and has been of great value to vessels loading and unloading there.

Appropriations to date for this harbor have been made as follows, viz:

Date.	Application.	Amount.
June 14, 1880	Dredging shoal east of railroad wharf	$2,500
Mar. 3, 1881	Dredging shoal east of railroad wharf	4,300
Aug. 2, 1882	Dredging shoal east of railroad wharf	9,000
July 5, 1884	Dredging shoal east of railroad wharf	2,000
	Total	17,800

New London, the port of entry for the collection district of New London, is situated about 2.5 miles from Long Island Sound. The harbor is formed by the mouth of the Thames River.

New London light-house is located at the entrance to the harbor, on the west shore. Forts Trumbull and Griswold command the harbor from either side.

Money statement.

July 1, 1885, amount available	$160 64
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	160 64
Amount appropriated by act approved August 5, 1886	2,000 00
Amount (estimated) required for completion of existing project	4,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,200 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

For the following statistics of commerce of the port of New London I am indebted to the courtesy of the collector of the port:

	No. of vessels.	Total tonnage.	Value of cargoes.
Foreign entries	18	3,651	$101,778
Foreign clearances	1	128	....
Coastwise entries	51	8,729	....
Coastwise clearances	117	24,808	....

Customs collected, $10,648.28.

Chief articles of foreign commerce, logwood, bay rum, rum, molasses, and fertilizers.

In addition to the above there is much domestic commerce, of which no record is kept. A line of large freight and passenger steamers make trips to and from New York daily. A steamer runs daily to Greenport, Long Island, N. Y., and return, and in summer a steamer makes three trips weekly between Hartford, New London, and Sag Harbor. During the summer the harbor is much frequented by pleasure boats of all sizes.

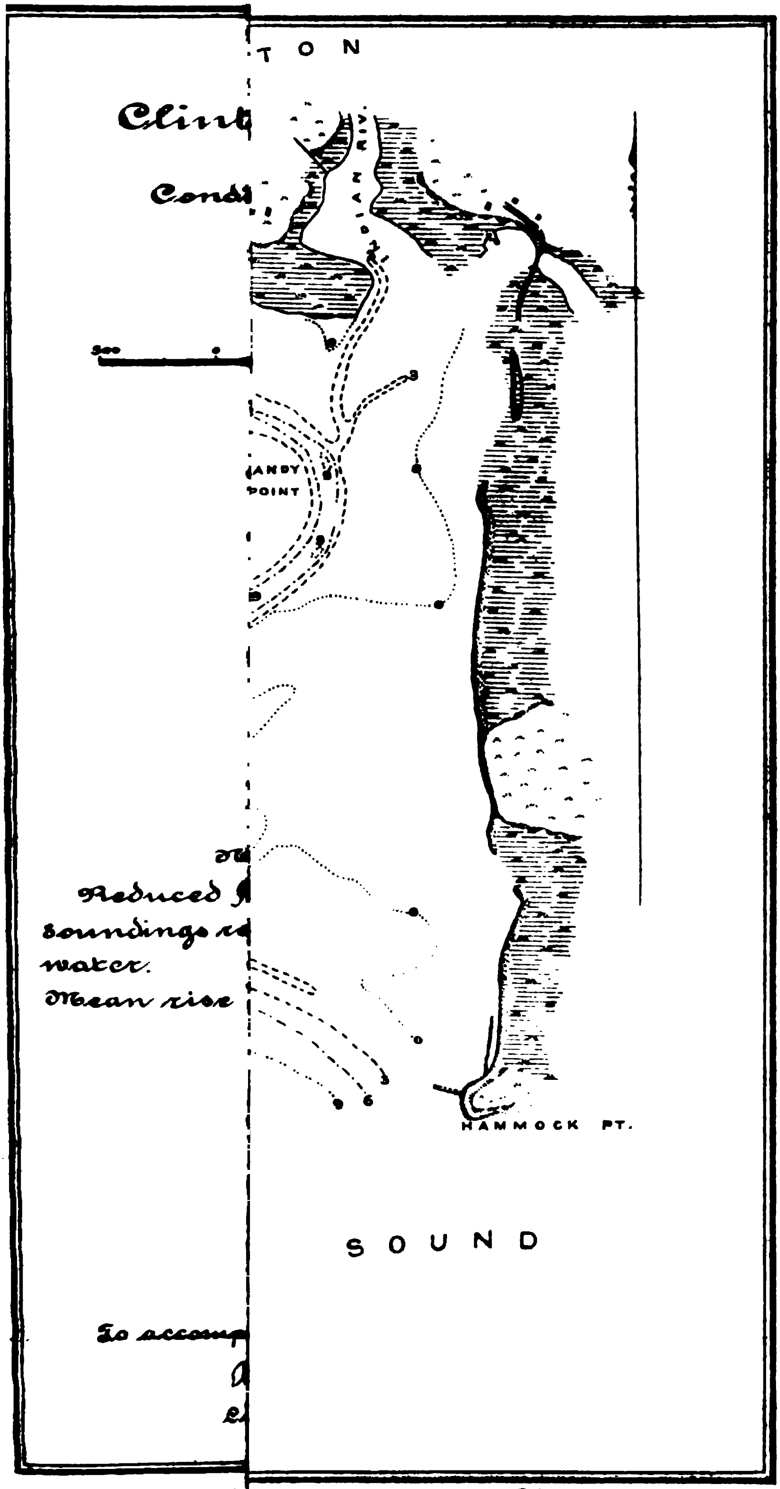
D 4.

IMPROVEMENT OF CLINTON HARBOR, CONNECTICUT.

Clinton Harbor is on the north shore of Long Island Sound, about 10 miles west of the Connecticut River. It consists of an open, shallow bay, and of the mouth of the Hammonasset River, a tidal stream which flows easterly in front of the town wharves and empties into the bay. For three-fourths of a mile above its mouth the river is separated from the bay by a narrow strip of sand and marsh. About forty-five years ago a break was made through this strip, one-half mile above the mouth of the river, which diverted a considerable part of the tides, and since then two shoals have formed, one just inside the river's mouth, with 4.5 feet of water, and one out in the bay, shortly before reaching the deep water of the sound, with a depth of 4 feet. It is said that formerly there were depths of from 8 to 12 feet on both these bars, and that shoaling occurred soon after the breach was made.

PROJECTS FOR IMPROVEMENT.

The first survey of this harbor was made in 1881, and a project for improvement submitted and adopted in 1882, which consisted in closing the breach by a riprap stone dike, and after sufficient time had elapsed,



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THE AMERICAN GRAPHIC CO., N.Y.

Money statement.

July 1, 1885, amount available	$160 64
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	160 64
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Amount (estimated) required for completion of existing project	4,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,200 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

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D 4.

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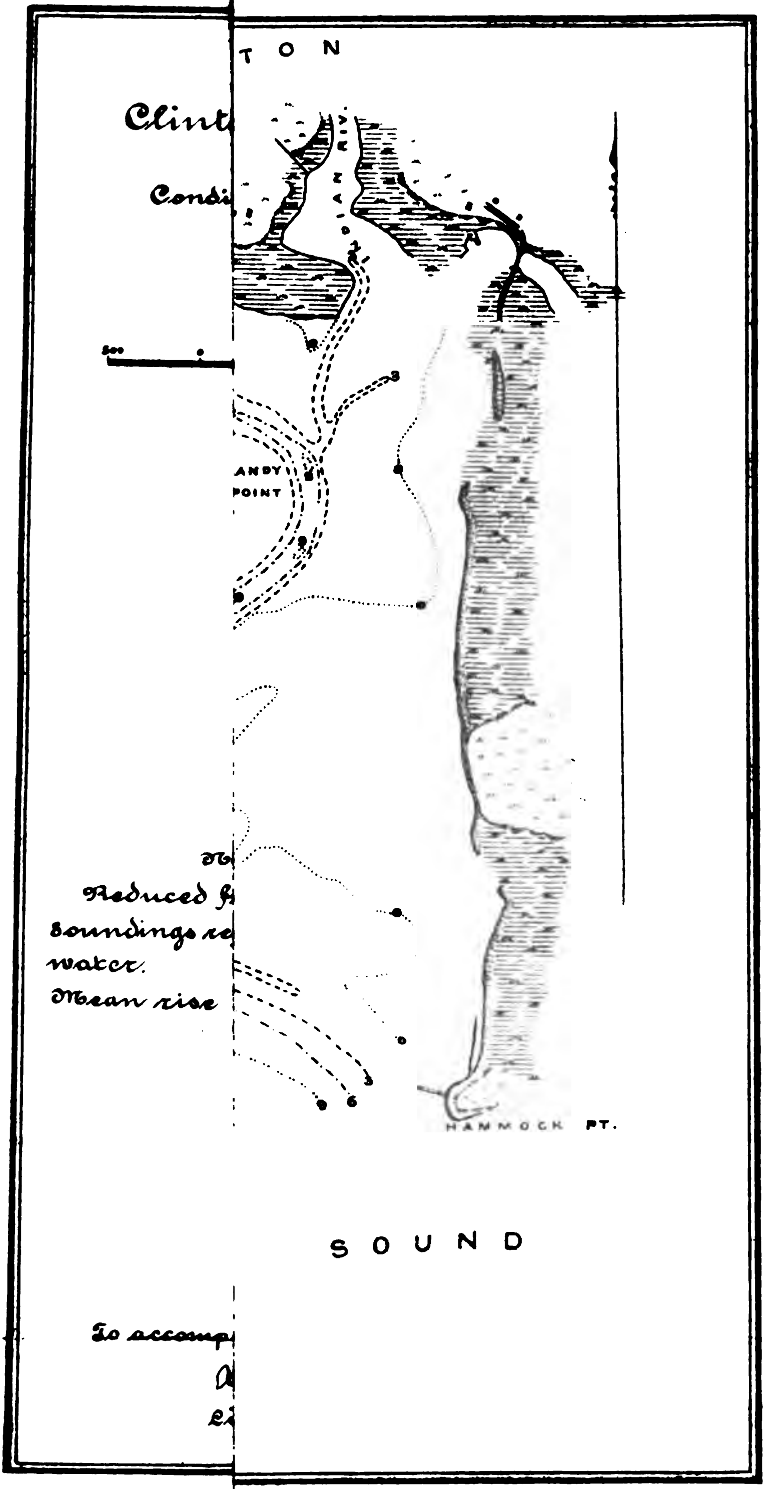

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THE AMERICAN GRAPHIC CO., N.Y.

f the desired depth was not restored by the increased tidal flow, to redge channels 100 feet wide and 6 feet deep at mean low water through he two shoals. Three thousand dollars was estimated as the cost of the ike and $10,000 as the cost of the whole project, including the dredging. (See Annual Report of the Chief of Engineers for 1882, Part I, page 630.)

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The available funds were not sufficient to continue the improvement. An examination of the harbor was made in September, 1885.

PRESENT CONDITION OF THE IMPROVEMENT.

The dike was built in 1883, using 1,574 tons of riprap granite, and costing, exclusive of superintendence, $2,219.34. The recent examination shows that it has settled an average of about 2 feet, and will require 500 tons of stone to bring it up to full height; also, that no material change has taken place in the channel since the completion of the dike. It seems now fairly well established that the increase of tidal flow will not scour the channel to the desired depth without some dredging.

PROPOSED OPERATIONS.

It is proposed to complete the project by dredging a channel 100 feet wide and 6 feet deep at mean low water through the two shoals in the harbor as soon as the estimated funds, $7,000, are appropriated.

Appropriations to date for this harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1881	Survey	*$500
Aug. 2, 1882	Construction of dike	3,000
	Total	3,500

* Allotment from general appropriation for surveys.

Clinton Harbor, Connecticut, is in the collection district of Middletown, on the north shore of Long Island Sound, 9 miles west of the mouth of the Connecticut River. The nearest light-house is on Falkner's Island, 8 miles southwest. Fort Trumbull, New London Harbor, Connecticut, is 23 miles east, and is the nearest work of defense.

Money statement.

July 1, 1885, amount available	$306 73
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	54 00
July 1, 1886, amount available	252 73
Amount (estimated) required for completion of existing project	7,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

For the following statistics I am indebted to the courtesy of the collector of customs at Middletown, Conn.:

Number of vessels entered and cleared	30
Tonnage (total)	3,000
Value of cargoes	$24,000

Chief articles of commerce are coal, wood, and oysters.

The greater part of the commerce of Clinton is carried on by rail.

D 5.

IMPROVEMENT OF NEW HAVEN HARBOR, CONNECTICUT.

New Haven Harbor is a bay on the north shore of Long Island Sound, extending about 4 miles inland, and from 1 to 2 miles wide. The Mill and Quinnipiac rivers empty into the head of the harbor. These rivers are of no commercial importance, except for tidal navigation about a mile above their mouths. The harbor channel is from 400 feet to 1 mile in width, with mud and sand flats on either side. When the Government began work in this harbor in 1867, the available low-water depth above Fort Hale—about half-way up the harbor—was 9 feet. Opposite Fort Hale it was 18 feet or over, but a short distance below was a bar of soft mud extending across the harbor, with depths from 13 to 15 feet. The mouth of the harbor was obstructed by several sunken rocks.

PROJECTS FOR IMPROVEMENT.

Several plans for removal of some of the rocks at the entrance have been proposed and undertaken with indifferent success. The removal of the harbor light to Southwest Ledge, and the completion of the present plan for breakwaters, will obviate the necessity of further work on the rocks.

The first project for deepening the channel of this harbor provided for making 13 feet depth at mean low water up to the city wharves. This was begun, and the required depth obtained in 1871. In 1872 and 1873 the bar below Fort Hale (about 2 miles below the city of New Haven) was dredged 16 feet deep, but on account of the very soft nature of the material the channel nearly filled up in a few months. Greater depth in the upper harbor was desired, and in 1875–'77 a project was proposed and adopted, providing for a channel 16 feet deep above Fort Hale. To increase the depth over the Fort Hale Bar, it was proposed in 1879 to contract the channel there by means of a dike from Sandy Point, on the west side of the harbor. This plan being recommended by Board of Engineers for Fortifications and River and Harbor Improvements, and being approved by the Chief of Engineers, work upon it was begun in 1883. The dike was to consist of a channel arm parallel to the channel and connected with the west shore at Sandy Point.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

Dredging was done by hired labor and by contract to enlarge the water-way under Tomlinson's Bridge, and to widen the channel above Long Wharf, in order to afford anchorage to light-draught vessels without blocking the main channel. Work by hired labor was begun August 10, at which time Tomlinson's Bridge was being partially rebuilt. Two old piers and part of the east abutment of the old bridge were removed, and an area extending about 120 feet across the channel and 30 feet above and below the bridge was dredged 18 feet deep. The material removed consisted of masonry, riprap, sand, gravel, mud, logs, and old crib-work, amounting to 3,116 cubic yards measured in place, and costing 75 cents per cubic yard. The channel from Tomlinson's Bridge to the Sewer Dock was widened on the east side from 40 to 120 feet, the depth made being 12 feet at mean low water; 20,000 cubic yards of mud were removed. Advertisement by circular was made, proposals were received, and September 9 a contract was made with Henry Du Bois' Sons, of New York, to dredge about 50,000 cubic yards at the rate of 8½ cents per cubic yard. Work was begun immediately, and was completed October 9, 1885, 44,192 cubic yards of mud having been removed. The channel was widened 80 feet on the east side from opposite the Sewer Dock to and around the bend opposite Long Wharf, making 13 feet depth at mean low water; and on the west side of the channel, half way between the Sewer Dock and the Canal Railroad Dock, an anchorage basin, 400 feet by 200 feet, was dredged 8 feet deep.

PRESENT CONDITION OF IMPROVEMENT.

The available depth over Fort Hale Bar is about 13 feet at mean low water. Above this there is a 16-foot channel up to Tomlinson's Bridge, with width from 400 to 600 feet. Just below the Sewer Dock, on the west side of the channel, is an anchorage basin of about 2 acres area and 8 feet deep, and on the east side of the channel above Long Wharf an additional width of about 100 feet has been dredged 12 feet deep or over. The shore-arm, 2,140 feet long, and 254 feet of the channel-arm of the Sandy Point Dike, have been built; 1,294 feet of the inner end of the shore-arm are built of riprap stone; the rest is of close piling, with longitudinal timbers and cross-ties, 8 feet wide over all, and filled with stone. All the timber work is creosoted.

PROPOSED OPERATIONS.

The project for deepening the channel across the Fort Hale Bar, which consists of a dike from the west shore (already begun) and dredging, ought to be completed as soon as possible. The work could readily be done in one year, and $100,000 is estimated for finishing the dike, and for the necessary dredging.

Appropriations for the improvement of New Haven Harbor have been made, as follows, viz:

Date.	Application.	Amount.
Aug. 30, 1852	Removal of middle rock, not expended until 1867	$6,000
July 11, 1870	Removal of rocks	15,000
Mar. 3, 1871	Dredging (13 feet) above Fort Hale	40,000
June 10, 1872	Dredging (16 feet) above Fort Hale, removal of rocks	35,000
Mar. 3, 1873	Dredging (16 feet) above Fort Hale	25,000
Mar. 3, 1875	Dredging (13 feet) above Long Wharf	10,000
June 18, 1878	Dredging (16 feet) Long Wharf to Fort Hale	25,000
Mar. 3, 1879	Dredging (16 feet) above Long Wharf	15,000
June 14, 1880	Dredging (16 feet) above Long Wharf	15,000
Mar. 3, 1881	Dredging (16 feet) Long Wharf to Fort Hale	15,000
Aug. 2, 1882	Dike opposite Fort Hale	30,000
July 5, 1884	Dredging (18, 12, and 8 feet) above Long Wharf	10,000
	Total	241,000

New Haven, the port of entry for the collection district of New Haven, is situated at the head of New Haven Harbor, about 3¼ miles from Long Island Sound. There is a light-house on Southwest Ledge, at the mouth of the harbor. Fort Hale, 2 miles below the city, commands the channel.

Money statement.

July 1, 1885, amount available		$10,276 82
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,850 58	
July 1, 1886, outstanding liabilities	290 00	
		10,140 58
July 1, 1886, amount available		136 24
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,136 24

Amount (estimated) required for completion of existing project	$80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	80,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received and opened at 11 *a. m., September* 7, 1885, *dredging in New Haven Harbor, Connecticut.*

No.	Names and addresses of bidders.	Price per cubic yard.	Cost of 50,000 cubic yards.
1	H. N. and A. J. Beardsley, Bridgeport, Conn	$0 09½	$4,750
2	William H. Taylor, jr., Jersey City, N. J	11	5,500
3	*Henry Du Bois' Sons, New York, N. Y	08½	4,250

* Contract awarded to Henry Du Bois' Sons, dated September 9, 1885, and completed October 9, 1885.

COMMERCIAL STATISTICS.

The following statement of commerce of the port of New Haven is furnished by the courtesy of the collector of customs:

FOREIGN COMMERCE.

	Number.	Value of cargoes.
Vessels entered	50	$560,794 43
Vessels cleared	19	82,125 66

Duties and miscellaneous receipts, $261,974.49.

The total amount of merchandise in weight received by water, not including coal, iron, and lumber, is 389,912 tons; and the chief articles of commerce consist of sugar, molasses, rum, coal, iron, lumber, potatoes, and various other products in large quantities.

DOMESTIC COMMERCE.

Steamers entered and cleared	2,720
Sailing vessels and barges entered and cleared	7,240

RECEIPTS OF MERCHANDISE.

Coal, 711,283 tons	value	$3,200,773
Iron, 82,000 tons	do	1,476,000
Lumber	do	2,500,000
Miscellaneous	do	68,056,339
Shipment of merchandise	do	57,215,830
Total		132,448,942

RECAPITULATION.

Value of merchandise imported	$560,794
Value of merchandise exported	82,125
Value of merchandise received coastwise	68,056,339
Value of merchandise shipped coastwise	57,215,830
Coal, iron, and lumber	7,176,773
Total	133,091,861

D 6.

CONSTRUCTION OF BREAKWATER AT NEW HAVEN, CONNECTICUT.

PROJECT.

The importance of a harbor of refuge at the entrance to New Haven Harbor had been urged by memorials to Congress, and set forth in annual reports of the Chief of Engineers, when, March 3, 1879, the first appropriation was made for the construction of a breakwater. The subject was referred to the Board of Engineers for Fortifications and for River and Harbor Improvements, who presented to the Chief of Engineers, on November 24, 1879, a project, which was approved by the Secretary of War January 31, 1880, and is printed in full in the Annual Report of the Chief of Engineers for 1880, Part I, pages 448–456. The project provides for the construction of two detached breakwaters at the entrance to New Haven Harbor, to form a harbor of refuge for vessels of 20-feet draught. The easterly breakwater is to extend from the light-house on Southwest Ledge to Quixes Reef, 3,300 feet. The westerly one is to commence in the vicinity of Luddington Rock and to extend about 4,200 feet in a northwesterly direction. Its location and length have not yet been exactly determined. Both breakwaters were to be of riprap granite, reaching 6 feet above mean high water, 12 feet wide on top, with side slopes of 1 on 3 on the outside and 2 on 3 on the inside. The average height of the east breakwater above bottom is 32 feet; that of the west breakwater will be 28 feet.

The cost was estimated as follows:

Locality.	Work performed.	Amount.
East breakwater	328, 900 cubic yards in work, at $2	$657, 800
West breakwater	326, 667 cubic yards in work, at $2	653, 334
Total		1, 311, 134

A modification in the cross-section was proposed by the officer in charge, and approved by the Chief of Engineers February 14, 1880, making the outer slope 1 on 2 and the inner slope 1 on 1. This would reduce the estimate for the east breakwater to $480,000, but as the location and length of the west breakwater are not definitely fixed, its cost may be greater than was estimated, and it has been thought advisable to retain the total estimate first given, viz, $1,311,134.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

No work has been done on the breakwater, the funds available being insufficient to resume operations with. Cross-sections of the completed part of the east breakwater were made in June, 1886.

PRESENT CONDITION OF WORK.

The east breakwater is now 2,147 feet long, being nearly two-thirds of its projected length. It contains 189,898 tons of granite, and has cost, including contingencies, about $100 per linear foot.

PROPOSED OPERATIONS.

In their report of November 24, 1879, submitting the project, the Board of Engineers expressed "the opinion that after the completion of a certain portion of the easterly breakwater the westerly one should be promptly commenced." It would seem advisable to commence the westerly breakwater now, and to continue work on the easterly one at the same time. For work on the two breakwaters $500,000 could be profitably expended during the ensuing fiscal year.

Appropriations for the New Haven Breakwater have been made as follows, viz:

Application.	Extent.	Amount.	Date.
	Feet.		
Building breakwater	348	$30,000	March 3, 1879.
Do	342	30,000	June 14, 1880.
Do	535	60,000	March 3, 1881.
Do	592	60,000	August 2, 1882.
Do	330	40,000	July 5, 1884.
Total	2,147	220,000	

New Haven, the port of entry for the collection district of New Haven, is situated at the head of New Haven Harbor, about 4 miles north of the breawater. There is a light-house on Southwest Ledge, the west terminus of the east breakwater, and Fort Hale, 2 miles north from the breakwater, commands New Haven Harbor.

Money statement.

July 1, 1885, amount available		$3,032 49
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,476 63	
July 1, 1886, outstanding liabilities	140 00	
		1,616 63
July 1, 1886, amount available		1,415 86
Amount appropriated by act approved August 5, 1886		75,000 00
Amount available for fiscal year ending June 30, 1887		76,415 86
Amount (estimated) required for completion of existing project		1,016,134 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

D 7.

IMPROVEMENT OF MILFORD HARBOR, CONNECTICUT.

GENERAL DESCRIPTION.

This harbor is on the north shore of Long Island Sound, about 9 miles southwest of New Haven, Conn. It consists of a broad, open bay, from the head of which a small tidal stream extends three-quarters of a mile inland, to the Milford wharves.

The original depth on the bar at the mouth of the river was 2 feet at mean low water, and in some places between there and the upper wharves the channel ran nearly bare.

PROJECTS FOR IMPROVEMENT.

The first project, adopted in 1872, provided for—

1. A riprap breakwater from Welch's Point, on the east side of the mouth of the harbor	$67,000
2. Protecting the bluffs on the east shore from erosion, by means of small stone jetties	5,500
3. Dredging 4 feet deep and 100 feet wide across the bar at the mouth of the river	6,250
4. A jetty on the east side of the channel to prevent the dredged area filling, and to confine the action of the tide	5,000
Superintendence	1,250
Total	85,000

This project, except the breakwater, was completed in 1881, and in 82 a channel 40 to 60 feet wide and 4 feet deep had been extended up e stream to the village wharves. In 1881 Major Barlow made an esmate for dredging a channel 8 feet deep and 100 feet wide through the r at the mouth of the river, at a cost of $11,000; $5,000 has been exnded towards this channel. In 1882 a survey for a breakwater and rbor of refuge was made, and plans and estimates of cost submitted. ee Annual Report of Chief of Engineers for 1882, Part I, page 632.)

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The funds available were not sufficient to continue the improvement. n examination of the mouth of the river and of the bar just below was ade in September, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The channel of 4 feet depth at mean low water was made 60 feet wide or two-thirds of the way from the mouth of the river to the upper harves, and 40 feet wide the rest of the way; it is in good condition, ith no material changes.

The channel across the bar, made 8 feet deep and 65 feet wide, has lled slightly, 7 feet being about its available depth now. The jetties eed some repairs.

PROPOSED OPERATIONS.

Whenever funds become available, it will be desirable to complete he 8-foot channel through the bar to the projected width of 100 feet; 6,000, the remainder of the estimated cost, could be profitably expended n this work in the fiscal year ending June 30, 1888.

Appropriations for Milford Harbor have been made as follows, viz:

Date.	Application.	Amount.
une 10, 1872	Survey	$1,500
une 23, 1874	Jetties on east shore	5,000
ar. 3, 1875	Long Jetty and dredging mouth of river	13,000
une 18, 1878	Dredging to Town Wharf	10,000
une 14, 1880	Dredging above Town Wharf and below Merwin's Wharf	5,000
ar. 3, 1881	Survey for breakwater	100
ug. 2, 1882	Dredging (8 feet) below Merwin's Wharf	5,000
	Total	39,600

Milford Harbor, Connecticut, is in the collection district of New Haven; it is about miles west from Fort Hale, New Haven Harbor. The nearest light-house is on Stratford Point, 4 miles to the westward.

Excepting the oyster business, which is conducted on rather a large scale, and one fish-oil works, the harbor is only of local importance.

Money statement.

July 1, 1885, amount available	$269 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	28 27
July 1, 1886, amount available	241 02
Amount (estimated) required for completion of existing project	6,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statement of commerce of Milford Harbor is supplied through the courtesy of the collector of customs at New Haven:

Vessels entered and cleared.	Number.	Total tonnage.
Steamers	450	13,5[illegible]
Sailing vessels	221	11,[illegible]

Value of cargoes received	$100,45[illegible]
Value of cargoes shipped	10[illegible],[illegible]

The chief articles of commerce are oysters, fertilizers, fish-oil, and coal.

D 8.

IMPROVEMENT OF HOUSATONIC RIVER, CONNECTICUT.

The Housatonic is a long, shallow river, running southward through Massachusetts and Connecticut, and emptying into Long Island Sound just east of Stratford Point, about 15 miles southwest of New Haven. At Derby, 13 miles above its mouth, it receives the discharge of the Naugatuck, a small, rapid river. This point, which has been regarded as the head of navigation, is nearly the head of tide-water; about 1 mile above there is a dam across the Housatonic River, furnishing large water-power. For at least 5 miles below Derby the water is always fresh.

The original depth on the worst bars in the river, 6 in number, varied from 3.5 to 4.5 feet at mean low water; there was also a bar across the river's mouth, with about 4 feet low-water depth.

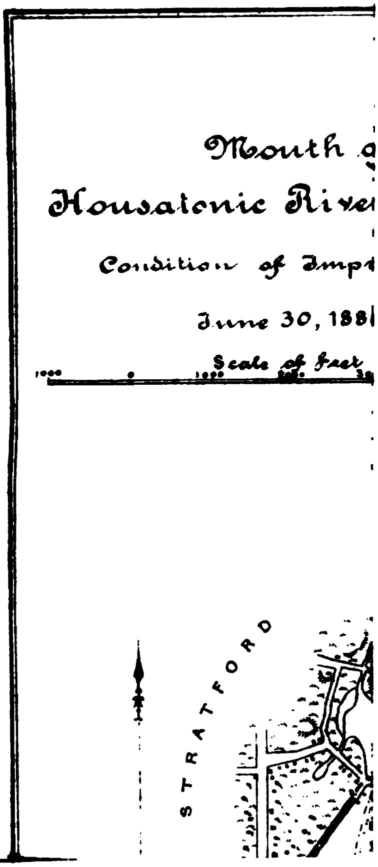
PROJECT FOR IMPROVEMENT.

In 1871 a project for the improvement of the river was submit which provided for a channel 100 feet wide and 7 feet deep at low ter from Derby to Long Island Sound, to be secured by means of je and dredging in the river, and by dredging over the bar at the mo after the location had been protected by a breakwater from Mil beach, on the east shore at the mouth.

The estimated cost was as follows:

Jetty at Sow and Pigs Reef	$4,
Removing Drew's Rock, 357 cubic yards	2,
Dredging inside the bar	18,
Dredging on the bar at the mouth	12,
Construction of breakwater at mouth	368,
Total	404,

This project was subsequently modified to admit of a jetty connecti Drew's Rock with the west bank, and in 1879 Major Barlow present an estimate of $12,000 for a riprap jetty to take the place of the bre water at the mouth of the river; in 1882 this estimate was altered about $20,000, and has been incorporated into the estimate for completing the project; the jetty contemplated was 6,000 feet long, rising only to low-water level.



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OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The material of which the bar at the mouth of the river consists is considered excellent for oyster-beds, and at intervals for several years offers have been made by oyster-growers to dredge more or less of this bar free of expense to the United States, they to have the material dredged; the work to be done as a harbor improvement under direction of the Engineer officer in charge. With the approval of the Secretary of War a contract of this kind was entered into with Lewis & Merwin, of Stratford, Conn., to dredge a channel 35 feet wide and 7 feet deep at mean low water through the bar. Work was begun July 29 and finished September 9, 1885, a channel of the required dimensions and 2,000 feet long having been made, and 14,394 cubic yards of sand, gravel, and shells having been removed. February 1, 1886, another contract of the same nature was made with the same parties to make a channel 9 feet deep and 70 wide; work under this contract began June 17, 3,418 cubic yards being dredged before the close of the fiscal year.

An examination of the outer bar was made in October, 1885, and an examination of the bars in the river was begun in June, 1886.

PRESENT CONDITION OF IMPROVEMENT.

Though the bars in the river have been repeatedly dredged to 7 feet depth at mean low water, the present available depth on them is only from 5 to 6 feet.

PROPOSED OPERATIONS.

Should sufficient appropriations be made, the breakwater at the mouth of the river will be built, Drew's Rock will be removed, and the channel in the river will be deepened wherever the bars have formed again. The estimated cost of this work is $30,000; it could be done to advantage in a single year.

Appropriations for the Housatonic River have been made as follows, viz:

Date.	Application.	Amount.
July 11, 1870	Survey	$2,700
Mar. 3, 1871	Sow and Pigs Jetty, dredging	15,000
June 10, 1872	Drew's Rock Jetty, dredging	15,000
Mar. 3, 1873	Dredging	10,000
June 23, 1874	......do	10,000
Mar. 3, 1875	Dredging by hired labor	5,000
June 18, 1878	Dredging	5,000
June 14, 1880	..... do	2,000
Mar. 3, 1881	......do	2,000
Aug. 2, 1882		2,000
July 5, 1884		2,500
	Total	71,200

The Housatonic River is the boundary between the collection districts of New Haven and Fairfield. The nearest light-house is on Stratford Point, at the mouth of the river, and the nearest work of defense is Fort Hale, New Haven Harbor, about 13 miles east.

Money statement.

July 1, 1885, amount available	$4,495 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,155 03
July 1, 1886, amount available	3,340 82
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	8,340 82

Amount (estimated) required for completion of existing project	$25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statement of commerce of this river is supplied through the courtesy of the collector of customs at New Haven:

Vessels entered and cleared.	Number.	Total. Tonnage.	Value of Cargo.
Steamers	78	11,700	
Sailing vessels	217	38,600	
Received			$255,000
Shipped			161,000
Total			416,000

A regular steamboat line has been recently established between Derby and New York, and it is believed that the value of freight received and shipped will be largely increased during the ensuing year.

D 9.

IMPROVEMENT OF BRIDGEPORT HARBOR, CONNECTICUT.

This harbor extends nearly 3 miles inland from the north shore of Long Island Sound, its width of about 1 mile at the mouth decreasing to 200 feet between opposite wharves at the upper end.

The channel, even in the widest part, is comparatively narrow. Before the first work by the United States was done at this harbor the depth over the bar was about 5 feet at low water, equivalent to 11.5 feet at high water.

PROJECTS FOR IMPROVEMENT.

In 1871 a project was submitted for a channel 200 feet wide and 14 feet deep at mean low water and for a breakwater from Long Beach to arrest the littoral movement of sand. As finally adopted, the depth of the channel was made 12 feet, and a riprap jetty was substituted for the breakwater. This had been completed in 1882, the channel being dredged 300 feet wide or more, when a project was adopted to make a width of 600 feet between the inner beacon and the Naugatuck Railroad Wharf, to be used as a harbor of refuge. The estimated cost was $60,000, of which $15,000 have been appropriated.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The funds available were insufficient for continuing the improvement. An examination of the harbor was made in September, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The 12-foot channel over the outer bar is but 75 feet wide, the 11-foot channel is over 200 feet wide. Thence to the inner bar and across that to the inner beacon the width is 300 feet or more. Above the inner beacon the channel width is 300 to 450 feet, but in many places are shoals, some with as little as 9½ feet depth. Above the Naugatuck Railroad Wharf this shoaling seems to be all across the channel; below that wharf it is principally on the west side.

PROPOSED OPERATIONS.

With future appropriations it is proposed to continue the project of widening the channel between the inner beacon and the Naugatuck Railroad Wharf, in order to provide a refuge for vessels driven in by stress of weather without blocking up the main channel. If the shoals in the upper harbor have increased since the examination of last September, it will be necessary to redredge such places.

Appropriations for the improvement of Bridgeport Harbor have been made as follows, viz:

Date.	Application.	Amount.
July 4, 1836	Dredging outer bars	$10,000
Aug. 30, 1852	Dredging outer and inner bars	10,000
June 23, 1866	Survey	Unknown.
July 11, 1870	Survey	Unknown.
Mar. 3, 1871	Dredging and 521 feet of jetty	20,000
June 10, 1872	Dredging and 850 feet of jetty	40,000
Mar. 3, 1873	Dredging inner bar and upper harbor	30,000
June 23, 1874	Dredging, bridge to Long Island Sound (9 feet)	20,000
Mar. 3, 1875	Dredging, bridge to Long Island Sound (12 feet)	15,000
Aug. 14, 1876	Dredging upper harbor (9 feet)	10,000
June 18, 1878	Dredging above bridge and outer bar (9 and 12 feet)	10,000
Mar. 3, 1879	Dredging, bridge to Long Island Sound (12 feet)	10,000
June 14, 1880	Dredging, bridge to Long Island Sound (12 feet)	10,000
Mar. 3, 1881	Dredging above inner beacon (12 feet)	10,000
Aug. 2, 1882	Dredging between inner beacon and railroad wharf (12 feet)	10,000
July 5, 1884	Dredging between inner beacon and railroad wharf (12 feet)	5,000
	Total	210,000

Bridgeport, the port of entry for the collection district of Fairfield, is situated about 2 miles from Long Island Sound, at the head of Bridgeport Harbor. There is a light-house at the entrance to the harbor, and Fort Hale, New Haven Harbor, the nearest work of defense, is 18 miles east.

Money statement.

July 1, 1885, amount available	$792 78
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	619 30
July 1, 1886, amount available	173 48
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	20,173 48
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statement is supplied by the courtesy of the collector of customs:

Foreign commerce:

Vessels arrived	10
Tonnage	1,365
Vessels cleared	8
Tonnage	1,103
Value of imports	$10,019 56
Customs collected	$2,075 55

Domestic commerce:	
Estimated value of cargoes received	$38,457,500 00
Estimated value of cargoes shipped	38,707,500 00
Estimated number of vessels entering harbor for refuge	1,200

For the following statement of domestic commerce, I am indebted to the harbor master of Bridgeport:

Number of arrivals of vessels:		
Steamers		4,703
Schooners		1,800
Sloops		3,600
Coal barges and canal boats		5,223
Principal freights received:		
Lumber	feet..	23,785,000
Coal	tons..	214,063
Iron	tons..	18,541
Other merchandise, principally building and manufacturing materials, about	tons..	25,000

Vessels carrying 209,000 tons of coal took refuge in this harbor during the year. Two lines of steamers run daily between Bridgeport and New York, and one line between Bridgeport and Port Jefferson.

D 10.

IMPROVEMENT OF BLACK ROCK HARBOR, CONNECTICUT.

This harbor, 1½ miles long from northeast to southwest and from 300 to 2,500 feet wide, lies between the mainland on the west and Fairweather Island on the east, and includes the navigable part of Cedar Creek, a small tidal inlet which extends up into the western part of the city of Bridgeport and affords a water communication of great value to several large manufactories in its immediate neighborhood. It is in the interest of the city of Bridgeport that the improvement of Black Rock Harbor is desired.

The depth in the lower part of the harbor is from 6 to 12 feet at mean low water, and before work was done in Cedar Creek the depth was from 2 to 4 feet in a narrow and crooked channel.

The head of the harbor was separated from Long Island Sound on the southeast by a broad, flat sand-bar, which was bare at about half tide and joined Fairweather Island with the main shore.

PROJECTS FOR IMPROVEMENT.

Between 1836 and 1838, $21,550 were spent in constructing a sea-wall across a breach in the southern part of Fairweather Island. In 1882 a survey of the harbor was ordered by Congress, which was made and a project for improvement was submitted December 12, 1883. This project provided, first, for protecting the upper part of the harbor from the sea by building a breakwater over the bar north of Fairweather Island, to be about a half-mile long and 6 feet wide at the top, which was to be 3½ feet above mean high water, or 10 feet above low water; second, for making a channel 80 feet wide and 6 feet deep at mean low water, about 3,300 feet long, extending up Cedar Creek. The total estimated cost was $80,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

Work on the breakwater was in progress at the beginning of the year, 4,974 tons of stone having been put into the work. The contract was completed in October, 1885, 5,440 tons being delivered since July 1, making a total of 10,414 tons under the contract. The breakwater was built to its full length, 2,744 feet, in order to prevent the current from cutting a channel over the bar; its cross-section is still considerably less, both in height and width, than projected. The cost of the work so far done, exclusive of superintendence, is $12,705.08.

The rate per ton for riprap granite for this work ($1.22) was exceedingly low, being less than one-half the estimated rate.

An examination of the harbor was made in September, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The breakwater to connect Fairweather Island with the mainland is built to its full length, with diminished cross-section. The channel, dredged 35 feet wide and 6 feet deep in the spring of 1885, has filled somewhat, as was expected; it is now navigable at low water to vessels of 4½ feet draught. The sea-wall, built in 1836–38 across a breach near the south end of Fairweather Island, is still effective in keeping the sea from washing over into the harbor; it needs some repair.

PROPOSED OPERATIONS.

With future appropriations it is proposed to complete the project for making a channel 80 feet wide and 6 feet deep at mean low water to extend up Cedar Creek as far as the Forge Company's dock. This work could be advantageously completed in one year, and an appropriation of $20,000 is estimated for that purpose.

The only appropriation made for improving this harbor was made by act approved July 5, 1884—$20,000.

Black Rock Harbor is in the Fairfield collection district, of which Bridgeport is the port of entry. There is a light-house at the harbor entrance; Fort Hale, New Haven Harbor, the nearest work of defense, is 20 miles east.

Money statement.

July 1, 1885, amount available	$9,972 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	9,168 56
July 1, 1886, amount available	804 20
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,804 20
Amount (estimated) required for completion of existing project	55,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Abstract of contract for improving Black Rock Harbor, Connecticut, in force during fiscal year ending June 30, 1886.

Name and address of contractor.	Date.	Subject.	Price per ton.	Remarks.
John A. Bonker, New York, N. Y.	Mar. 26, 1885	Delivery of riprap granite	$1 22	Completed in October, 1885.

COMMERCIAL STATISTICS.

For the following statement concerning commerce in the vicinity of Cedar Creek, Black Rock Harbor, I am indebted to the courtesy of the harbor master at Bridgeport.

There are ten manufacturing concerns located here, most of them quite large; three of them report receipts amounting to 21,900 tons; the others would probably increase this amount to 40,000 tons. Rather more than half of this amount is unloaded at Bridgeport and hauled to the works; it will all be received at Cedar Creek when the proposed improvements are completed.

D 11.

IMPROVEMENT OF SOUTHPORT HARBOR, CONNECTICUT.

This harbor consists of the mouth of a small stream called Mill River, and of a broad, shallow bay on the north shore of Long Island Sound about 7 miles west of Bridgeport. Before any Government work was done on this harbor the navigable low-water depth was less than 2 feet, and the channel was in danger of becoming quite filled by drift sand from the beach to the east.

The mean rise of tide is 6.6 feet.

A history of work on this harbor up to 1879 may be found in the Annual Report of the Chief of Engineers for 1879, Part I, page 355.

PROJECTS FOR IMPROVEMENT.

The first project, adopted in 1827, provided for a stone breakwater extending southward 1,420 feet from the sand beach on the east side of the harbor, and for a dike extending 1,450 feet northward from the head of the breakwater, the object being to confine the water to the main channel and to prevent sand drifting in from the eastward. This was completed in 1838.

In 1875 the breakwater was repaired, and was built 2 feet higher, and in the same year, after a survey was made, Major Barlow submitted a project for dredging a channel 50 feet wide and 4 feet deep at mean low water from the wharves to Long Island Sound. This project, adopted in 1876, was extended in 1880 so as to make the channel 100 feet wide; it was virtually completed in 1883, the channel being made 95 feet wide from Long Island Sound to the end of the breakwater, 80 feet wide from there to White Rock; above White Rock instead of widening the channel it was prolonged in a Y at the special request of those interested in the harbor, there being no reason to the contrary.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

No work was done; an examination of the channel was made in September, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The breakwater and dike are both in fair condition, with no urge need of repairs. The examination of September last showed that the had been no material changes in the channel, and that it had an available depth of 4 feet at mean low water as far as dredged.

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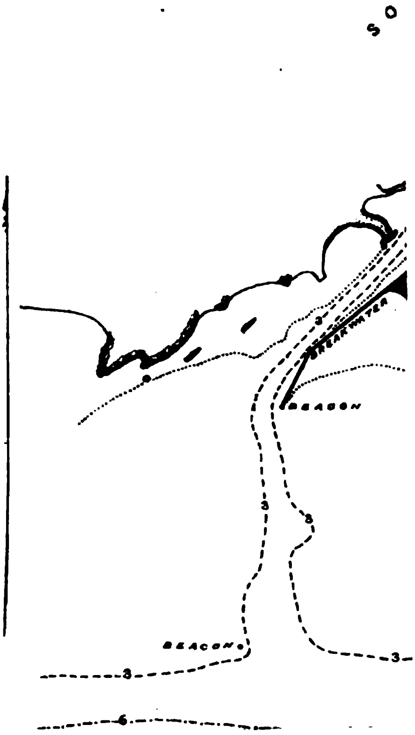
Notes:

Reduced from survey of 1885.

Curves refer to mean low water.

Mean rise of tide 6.67 ft.



PROPOSED OPERATIONS.

The approved project is completed, and no repairs or further improvement are required at present.

Appropriations for improving Southport Harbor have been made as follows, viz:

Date.		Application.	Amount.
Mar.	2, 1829	Breakwater, dike, and dredging	$6,097 00
July	3, 1832	Completing breakwater and dike, building beacons, and a small amount of dredging.	4,490 23
July	4, 1836		1,500 00
Mar.	3, 1837		1,000 00
July	11, 1870	Examination and report	Unknown.
Mar.	3, 1875	Repairs on breakwater	5,000 00
Aug.	14, 1876	Repairs on dike and dredging	5,000 00
June	14, 1880	Dredging upper harbor	2,500 00
Mar.	3, 1881	Dredging on bar	2,500 00
Aug.	2, 1882	Dredging upper harbor	3,000 00
		Total	31,087 23

Southport Harbor is in the Fairfield collection district, about 6 miles west of Bridgeport, which is the port of entry. The nearest light-house is on Penfield's Reef, 3½ miles east of the harbor. Fort Hale, New Haven Harbor, 24 miles east, is the nearest work of defense.

Money statement.

July 1, 1885, amount available	$159 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	79 47
July 1, 1886, amount available	79 60

COMMERCIAL STATISTICS.

The following statement of commerce of Southport Harbor is supplied by the courtesy of the collector of customs at Bridgeport:

Vessels arriving and departing		190
Tonnage		11,100
Chief articles of commerce:		
Coal	tons	6,000
Lumber	feet	150,000
Produce and general merchandise: Value of produce, &c., shipped from this harbor estimated at		225,000

D 12.

IMPROVEMENT OF NORWALK HARBOR, CONNECTICUT.

Norwalk Harbor, or River, is a tidal estuary with a narrow channel extending about 3 miles up from Long Island Sound to the town of Norwalk; above Norwalk the river is a small fresh-water stream. South Norwalk is on the west bank of the river, 1½ miles below Norwalk; at this point the river is crossed by two bridges, the lower one a wagon bridge, and the other, 450 feet above, the bridge of the New York, New Haven and Hartford Railroad. In 1867 a company was incorporated under the laws of the State of Connecticut for the improvement of this river; little work was done, and when the improvement was undertaken by the United States, the low-water depth to South Norwalk was 5 feet, and to Norwalk but 1 foot.

PROJECTS FOR IMPROVEMENT.

The first project for improving this harbor was based on a survey made in 1871; it provided for dredging a channel from Long Island Sound to the wharves at Norwalk, 100 feet wide and 6 feet deep at mean low water, at an estimated cost of $34,000.

In 1881 the project was modified to admit of making a depth of 8 feet below South Norwalk. The latest estimate, made to include the cost of this modification and of a large amount of dredging already required to maintain the channel, places the total cost, from the time of commencement, at $84,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

At the beginning of the fiscal year dredging between Gregory's Point and the wagon bridge at South Norwalk was in progress, under contract with H. N. Beardsley, dated March 27, 1885, to dredge to 8 feet depth at mean low water at the rate of 9⅞ cents per cubic yard; 15,464 cubic yards had been removed. The contract was completed July 18, 1885, 19,360 cubic yards additional being dredged, making a total under this contract of 34,824 cubic yards, costing, exclusive of supervision and contingencies, $3,438.87. The narrow parts of the 8-foot channel below South Norwalk were widened on the west side by from 40 to 80 feet, for a distance of about 4,600 feet below the wagon bridge. An examination of the harbor below South Norwalk was made in September, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The channel below South Norwalk, which has been dredged 8 feet deep and 100 feet wide, is somewhat short of the full dimensions, owing to mud filling in the old cut on the east side of the channel; it has, however, the required depth on the west part of the channel. Above South Norwalk the channel has been made 60 to 100 feet wide and 6 feet deep, and is believed to be in navigable condition.

PROPOSED OPERATIONS.

The estimated amount required to complete the existing project is $10.000, which could be advantageously expended in a single year in widening and straightening the channel.

Smaller appropriations will be required from time to time to maintain the channel after completion.

Appropriations for the improvement of Norwalk Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1829	Survey	$80 00
Mar. 3, 1871	......do	1,166 66
June 10, 1872	Dredging (6 feet) above South Norwalk	10,000 00
Mar. 3, 1873	......do	10,000 00
June 23, 1874	do	10,000 00
Mar. 3, 1875	Dredging (6 feet) below South Norwalk	7,000 00
June 18, 1878	..... do	6,000 00
Mar. 3, 1879	Dredging (6 feet) above and below South Norwalk	10,000 00
June 14, 1880	Dredging (8 feet) below South Norwalk	5,000 00
Mar. 3, 1881	Dredging (8 feet) below, and (6 feet) above South Norwalk	5,000 00
Aug. 2, 1882	Dredging (6 feet) above South Norwalk	5,000 00
July 5, 1884	Dredging (8 feet) below South Norwalk	5,000 00
	Total	74,246 66

Norwalk is in the Fairfield collection district, and is about 11 miles west of Bridgeport. Norwalk light-house is on Sheffield's Island, at the entrance to the harbor. The nearest works of defense are the fortifications at Throg's Neck, 29 miles west.

Money statement.

July 1, 1885, amount available	$3,713 34
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,960 12
July 1, 1886, amount available	753 22
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,753 22
Amount (estimated) required for completion of existing project	7,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Norwalk Harbor, Conn., in force during the fiscal year ending June 30, 1886.

Name and address of contractor.	Date.	Subject.	Price per cubic yard	Remark.
H. N. Beardsley, Bridgeport, Conn	Mar. 27, 1885	Dredging	$0.09⅛	Completed July 18, 1885.

COMMERCIAL STATISTICS.

The following statement of commerce of Norwalk Harbor is furnished by courtesy of the collector of customs at Bridgeport:

Vessels arriving and departing:		
Steamers		1,660
Sailing vessels		590
Barges		550
Freights received:		
Coal	tons	108,240
Iron	do	5,280
Lumber	feet	37,871,947
General merchandise	tons	64,278
Freights shipped:		
Lumber	feet	648,000
Ice	tons	15,000
General merchandise	do	58,530

D 13.

IMPROVEMENT OF PORT CHESTER HARBOR, NEW YORK.

This harbor consists of the lower part of the Byram River and of a bay at its mouth which opens into Long Island Sound. This part of the river is the dividing line between the States of New York and Connecticut. It is navigable up to the Port Chester Bridge, a little more than a mile above its mouth. Before improvement the depth below the wharves was in some places as little as 1 foot at mean low water. The mean rise of tide is 7.4 feet.

PROJECTS FOR IMPROVEMENT.

The first project, adopted in 1871, provided for the removal of two rocks: Sunken Rock, at the entrance to the bay, with 5.7 feet low-water depth, to be removed to 11 feet depth, and Salt Rock, about 1,000 feet above the river's mouth, partly bare at low water, to be removed to 9 feet depth; also a breakwater 400 feet long at Byram Point, estimated to cost as follows:

Sunken Rock, 1,474.5 cubic yards, at $40	$58,980
Salt Rock, 316.3 cubic yards, at $40	12,652
Breakwater at Byram Point	25,000
Total	96,632

Under this project Salt Rock was removed. No further work was done until 1884, when a survey of the channel was made under appropriation of August 2, 1882, and a project for making it from 60 to 100 feet wide and 3 feet deep at mean low water from the bay to the vicinity of the wharves was submitted and approved. This channel was completed in May, 1885.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

Examinations made in October, 1885, and in April, 1886, showed that there were some lumps in the channel near the mouth of the river, and that the irregularities of the previous dredging have not leveled themselves off as was expected. Citizens interested in the harbor laid great stress upon the importance of making the channel bottom along the dock front level, because their vessels lie aground at low tide. Therefore, with the approval of the Chief of Engineers, it was decided to spend the remainder of the appropriation in removing these lumps and in straightening and leveling the channel in front of the wharves, as well as extending it to the bridge. It was difficult to estimate the cost per cubic yard of such work, and a dredge with necessary appliances was hired under contract.

Advertisement was made, proposals were opened May 8, and a contract dated May 15, 1886, was entered into with M. K. Pidgeon, of New York, for furnishing a suitable dredge, tug, scows, with crews and necessary appliances, at the rate of $83 per day of ten hours.

Up to the close of the fiscal year 3,096 cubic yards of sand and gravel had been removed in 295¾ hours' work, straightening and leveling the channel in the river, and removing lumps from the channel, both in the river and in the bay. The work is still in progress.

PRESENT CONDITION OF IMPROVEMENT.

Salt Rock has been effectually removed; no work has been done upon Sunken Rock. An available channel 2½ feet deep at mean low water and nearly 10 feet at high water, has been made up to the upper wharves. The completion of the present contract will leave this channel 40 feet wide, with the bottom as nearly level as may be.

PROPOSED OPERATIONS.

The removal of Sunken Rock to a depth of 11 feet at mean low water will be undertaken in accordance with the project when funds are appropriated for that purpose. No other improvement of this harbor seems to be required at present.

Appropriations for the improvement of Port Chester Harbor, New York, have been made as follows, viz:

Date.	Application.	Amount.
June 10, 1872	Removing Salt Rock	$12,000
August 2, 1882	Dredging in Byram River	15,000
	Total	27,000

Port Chester Harbor is in the collection district of New York. The nearest light-house is on Great Captain's Island, 1¾ miles east of the mouth of the harbor. The nearest work of defense is at Throg's Neck, about 15 miles southwest.

Money statement.

July 1, 1885, amount available		$4,913 18
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,403 56	
July 1, 1886, outstanding liabilities	942 54	
		3,346 10
July 1, 1886, amount available		1,567 08
Amount (estimated) required for completion of existing project		69,632 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredge, scows, tug, and necessary appliances for dredging in Port Chester Harbor, New York, opened May 8, 1886.

No.	Name and address of bidders.	Rate per day of 10 working hours.
1	The Hartford Dredging Company, Hartford, Conn	$125 00
2	M. K. Pidgeon, 60 South street, New York	83 00

Contract entered into with M. K. Pidgeon, May 15, 1886, in progress.

COMMERCIAL STATISTICS.

The following statistics of commerce are kindly furnished by Mr. William P. Abendroth, of Port Chester:

ARRIVALS AND DEPARTURES OF VESSELS.

Steamers	156
Tow-boats, &c	150
Barges, canal-boats, &c	140
Sailing vessels	167
Total tons of freight received and shipped	81,000

The chief articles of commerce are iron, coal, building materials, manufactures, and general merchandise.

D 14.

IMPROVEMENT OF HARBOR AT NEW ROCHELLE, NEW YORK.

New Rochelle Harbor is situated at the western end of Long Island Sound, on its north shore, about 10 miles west of the boundary line between the States of New York and Connecticut. The harbor lies off the southerly part of the town of New Rochelle, and Echo Harbor is off the northerly part.

New Rochelle Harbor consists of rather narrow and circuitous passages between several rocky islands and reefs, which shelter it from rough weather. It had originally an available depth of 8 to 9 feet at mean low water; there were two rocks near the channel-way whose removal was desired, and the narrowness of the deep-water channel rendered it difficult for vessels to turn.

PROJECTS FOR IMPROVEMENT.

Up to 1880 Echo Harbor was the port for New Rochelle. In that year a survey was ordered and made, and in the report of January 28, 1881, a project for improvement was submitted, contemplating the removal of Corning Rock to 12 feet depth, of Rock C to 9 feet depth, the dredging of channel 100 feet wide and 8 feet deep at mean low water around th south end of Glen Island to connect with the channel around the nort end of that island, and the removal of about 300 cubic yards of a re at the entrance to this dredged channel, at an estimated cost of $40,82 The object of the dredging was to allow vessels to pass around the islan instead of having to turn in the narrow channel. No modification this project has been made. In 1881 the channel around Glen Islan was dredged 100 feet wide and 6 feet deep, and work was begun under contract to remove the reef at the channel entrance to 8 feet depth. Th contract provided for payment of $9,000, to be made only when the re was removed to the required depth. The contract was twice extende and in 1883 work was abandoned by the contractor while parts of t rock were still from 1 to 1½ feet above the plane of removal. In 18 Corning Rock was removed to 12 feet depth by hired labor, at a cost about $34 per cubic yard; a large bowlder was removed from near D vid's Island wharf, and 10.6 cubic yards of loose rock were remov from the reef at the entrance to the dredged channel, making a dep of 7.5 feet there.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

No work has been done. An examination of the channel dredged i 1881 was made.

PRESENT CONDITION OF IMPROVEMENT.

An examination last fall showed that the dredged channel retaine its depth of 6 feet at mean low water. The depth over the reef at th entrance to this channel is 7.5 feet. Corning rock has been removed t a depth of 12 feet, and is no longer a source of danger. No work h been done upon Rock C.

PROPOSED OPERATIONS.

It is proposed to apply the funds now available towards the completion of the project, of which the following remains to be done:

(1) Removal of Rock C to a 9-foot depth.

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E

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(2) Making the dredged channel 8 feet deep. It is now 6 feet.

(3) Deepening the reef at the entrance to the dredged channel to 8 feet. It has already been removed to 7.5 feet.

The sum of $5,825, in addition to the amount available, is estimated to complete this project.

Appropriations for the improvement of New Rochelle Harbor have been made as follows, viz:

Date.	Application.	Amount.
March 3, 1881	Dredging and partial removal of rock at mouth of Glen Island Channel	$20,000
August 2, 1882	Removal of Corning Rock	15,000
Total		35,000

New Rochelle Harbor is in the collection district of New York. The nearest light-house is on Execution Rock. The fortifications at Throg's Neck, 7 miles west, are the nearest works of defense.

Money statement.

July 1, 1885, amount available	$18,210 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	704 24
July 1, 1886, amount available	17,506 37
Amount (estimated) required for completion of existing project	5,825 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The chief articles of commerce are coal, lumber, building materials, &c., for local use. A market steamer makes about 150 trips per year to and from New York, and about 250 sailing vessels enter per year.

Glen Island, New Rochelle Harbor, is a popular resort in summer, and excursion steamers make hourly trips to and from New York.

This includes the commerce of Echo Harbor, where most of the freight is received.

D 15.

IMPROVEMENT OF ECHO HARBOR, NEW ROCHELLE, NEW YORK.

This is a bay on the north shore of Long Island Sound, about 22 miles by water from the Battery at New York.

It is landlocked except on the southeast, and has a good anchorage; until the beginning of the improvement of New Rochelle Harbor, in 1881, it was the only port of the town of New Rochelle. The depth in the bay varies from 6 to 15 feet at mean low water, though the low-water channel up to the wharves is only from 1 to 2 feet deep.

The mean rise of the tide is 7.3 feet.

PROJECTS FOR IMPROVEMENT.

The first project, submitted December 20, 1875, provided for the removal of two rocky reefs from the channel, viz:

(1) Sheepshead Reef, lying midway between Echo Island and Duck Point, which had 1.6 feet of water upon it at low tide. This was to be removed to a depth of 9 feet at low water, which required the excavation of 872.5 cubic yards of rock, costing	$21,201 75
(2) Start Rock, which projected about 2 feet above low water, and lay in the channel 120 feet from Beaufort Point. This was to be removed to 6 feet below low water, requiring the excavation of 370 cubic yards of rock, costing	12,672 50
Contingencies	5,081 13
Total	38,955 38

A modification of the project made in 1878, provides for removing Start Rock to 7 feet depth instead of 6 feet. This depth over Start Rock was gained in January, 1880, and in 1881–'83 506 cubic yards were removed from the southern part of Sheepshead Reef, making 9 feet depth.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The money available was not enough to continue the projected work and nothing was done. An examination of the rocks in the harbor was made in October, 1885.

PRESENT CONDITION OF IMPROVEMENT.

Start Rock has been removed to the required depth, 7 feet, at mean low water, and about one-half of Sheepshead Reef has been removed to 9 feet depth. The condition of the channel is otherwise about the same as before the improvement, no other work having been done.

PROPOSED OPERATIONS.

With future appropriations the removal of Sheepshead Reef will be completed. Twenty-two thousand dollars have been appropriated for this project; with the balance of the estimate, $17,000, the project could be advantageously completed in a single year.

Appropriations for improving Echo Harbor, New Rochelle, N. Y., have been made as follows, viz:

Date.	Application.	Amount.
June 18, 1878	Removal of Start Rock	$10,000
March 3, 1879	......do	3,000
June 14, 1880	Removal of Sheepshead Rock	3,000
March 3, 1881	......do	3,000
August 2, 1882		3,000
Total		22,000

Echo Harbor is in the collection district of New York. The nearest light-house is on Execution Rock. The fortifications at Throg's Neck, 7 miles to the westward, are the nearest works of defense.

COMMERCIAL STATISTICS.

The commerce of this harbor is that of New Rochelle, and is included in the statement for New Rochelle Harbor.

Money statement.

July 1, 1885, amount available	$3,361 87
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	105 00
July 1, 1886, amount available	3,256 87
Amount (estimated) required for completion of existing project	17,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	17,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

D 16.

IMPROVEMENT OF MAMARONECK HARBOR, NEW YORK.

Mamaroneck Harbor, on the north shore of Long Island Sound, about 5 miles west of the Connecticut State line, consists of an open, shallow bay and a narrow tidal-inlet about a mile long. The channel to the old steamboat wharf (about half-way up the inlet) had a depth of 5 feet at mean low water; from there to the upper wharves the depths gradually decreased to 1 foot. Near its mouth the inlet was obstructed by several rocks. The mean rise of tide at Mamaroneck is about 8 feet.

PROJECTS FOR IMPROVEMENT.

A survey of the harbor was made in 1881, and a project for improvement was submitted and adopted providing for the removal of Round Rock to a depth of 4 feet and five other rocks to a depth of 7 feet; for dredging a channel 7 feet deep and 100 feet wide from the sound to the old steamboat wharf, and thence, 4 feet deep and 80 feet wide, to the upper wharves, and for closing the small channel east of Grassy Knoll, at an estimated cost of $43,000. In 1881 Round Rock was removed to a depth of 4 feet, and Bush Rock and Inner Steamboat Rock to 7 feet at mean low water, at a cost of $13,000, not including supervision and contingencies.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The available funds were not sufficient to continue work under the project. An examination of part of the harbor was made in October, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The available depth of channel has not changed since the original survey. The removal of three rocks has made the upper harbor much easier and safer of access.

PROPOSED OPERATIONS.

It is proposed, when funds are appropriated for the purpose, to complete the existing project by removing the other dangerous rocks and by dredging in the channel. This could be completed to advantage in a single year.

Appropriations for improving Mamaroneck Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1881	Survey	$500
Aug. 2, 1882	Removal of rocks	15,000
	Total	15,500

Mamaroneck Harbor is in the collection district of New York; its commerce is mainly of local importance. The nearest light-house is on Execution Rock, about 4 miles south; the fortifications at Throg's Neck, 9 miles southwest, are the nearest works of defense.

Money statement.

July 1, 1885, amount available	$301 23
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	77 00
July 1, 1886, amount available	224 23
Amount (estimated) required for completion of existing project	28,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	28,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

I am indebted to the collector of customs at New York for the following information about the commerce of Mamaroneck.

No record is kept of the arrival and departure of vessels. A market steamer makes about 150 trips per year to and from New York. About 150 vessels of different kinds arrive per year with domestic cargoes.

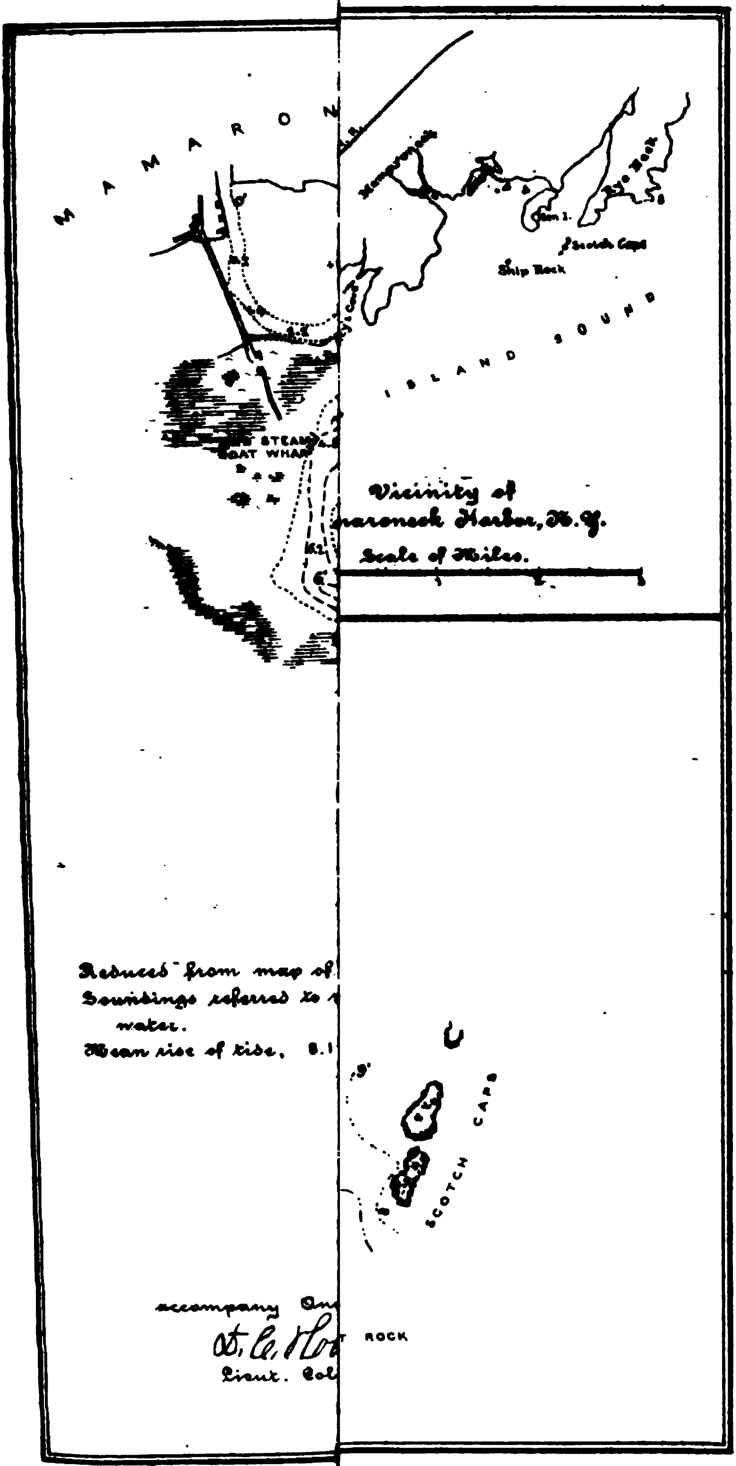
D 17.

IMPROVEMENT OF GREENPORT HARBOR, NEW YORK.

This harbor is a roadstead near the east end of Long Island, lying between the north prong of Long Island on the nothwest and Shelter Island on the southeast and south. Its anchorage ground is exposed to storms from the northeast and east. A sand-spit, called Joshua's Point, formerly protected the little bay at Greenport from easterly storms, but of late years this has worn away rapidly, and the sand has been carried into the bay. The mean rise of tide is 2.4 feet.

PROJECT FOR IMPROVEMENT.

In 1881 a survey was ordered, and, with the report, a plan and estimates were submitted for a breakwater extending southeasterly from Joshua's Point. This project, as adopted, consisted of a riprap breakwater, about 1,700 feet long, extending from high-water mark to the 18-foot curve; to be built 3 feet above mean high-water level, with top width of 5 feet and side slopes of 1 on 1, and to contain about 23,000 tons of stone. Its estimated cost was $46,000. Work under this project was begun in 1883, and in that and the two following years 1,233 linear feet of the breakwater were built.



Reduced from map of
Soundings referred to
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Mean rise of tide, 8.1

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THE AMERICAN GRAPHIC CO., N.Y.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The available funds were insufficient to continue construction, and no work was done. An examination of the harbor was made in September, 1885.

PRESENT CONDITION OF IMPROVEMENT.

The breakwater has been made 1,233 feet long, which carries it out to a depth of 10.5 feet at mean low water. Eleven thousand three hundred and seventy-three tons of riprap granite have been used in its construction. It is in good condition as far as completed. No material changes of depth in the harbor have occurred since the original survey.

PROPOSED OPERATIONS.

With future appropriations the breakwater will be completed, as projected, to the 18-foot curve. Twenty thousand dollars have been appropriated for this work; the remainder of the estimate, $26,000, could be profitably expended in completing the breakwater in one year.

Appropriations for improving Greenport Harbor, New York, have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1881	Survey	$500
Aug. 2, 1882	Expended on breakwater	10,000
July 5, 1884	......do	10,000
	Total	20,500

Greenport is a port of delivery in the collection district of Sag Harbor. The nearest light-house is on Long Beach Point, 3 miles to the eastward. The nearest work of defense in Fort Trumbull, New London Harbor, Connecticut, 21 miles distant in a straight line.

Money statement.

July 1, 1885, amount available	$300 78
July 1, 1886, amount available	300 78
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,300 78
Amount (estimated) required for completion of existing project	21,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	21,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statement of commerce of Greenport Harbor is furnished by the courtesy of the surveyor of customs at that port:

Class.	Arrivals.	Departures.
Steamers	1,828	1,830
Sailing-vessels	1,120	1,125

Chief articles of commerce, fishing products and local supplies.

D 18.

IMPROVEMENT OF PORT JEFFERSON HARBOR, NEW YORK.

This harbor is a large landlocked bay, on the north side of Long Island, in a direct line about 60 miles east of New York, and nearly opposite Bridgeport, Conn. Its high-water area, with that of its shallow tributaries, Setauket Harbor and Conscience Bay, is about 2¼ square miles, and the width of the outlet is but 450 feet. Port Jefferson lies at the head of the harbor, nearly 2 miles from the outlet, and there is a depth of 12 feet or more at low water to within 300 feet of the wharves, over nearly the whole width of the harbor. Originally there was a bar just outside the outlet, with a depth of 3 feet at mean low water, over which the tide ebbed and flowed very rapidly.

PROJECTS FOR IMPROVEMENT.

A survey of the harbor was made in 1853, but the first work done was under a project submitted in 1871 for building a breakwater or jetty on the east side of the entrance, and for dredging a channel 200 feet wide and 7 feet deep. This jetty was built 1,052 feet long in 1873, and in 1875, under a modification of the project, a similar jetty was begun on the west side of the entrance. In 1877 the project was again modified so as to increase the depth of the contemplated channel from 7 to 8 feet, and to reduce the width from 200 to 100 feet. From that date until 1883 both jetties have been extended, and the channel of the projected dimensions has been dredged.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

No work was done. An examination of the harbor was made i November, 1885.

PRESENT CONDITION OF THE IMPROVEMENT.

The east jetty is 1,390 feet long, ending in 10 feet of water; the we jetty is 940 feet long, ending in 6.5 feet of water. Both jetties are fair condition. The dredged channel retains nearly its depth of 8 fe at mean low water.

PROPOSED OPERATIONS.

The amount estimated for the completion of the project was reach by the last appropriation, made August 2, 1882, and the project its is completed. Whether the depth gained will be permanent or not c only be told by time. No further operations are proposed at presen

Appropriations for improving Port Jefferson Harbor, New York, ha been made as follows, viz:

Date.	Application.	Amou
Mar. 3, 1871	Applied to east jetty	$15,
June 10, 1872	......do	15,
Mar. 3, 1875	Applied to east and west jetties	15,
Aug. 14, 1876	Applied to east jetty and dredging	6,
June 18, 1878	Applied to both jetties	8,
Mar. 3, 1879	Applied to dredging	5,
June 14, 1880	Applied to both jetties	3,
Mar. 3, 1881	Applied to east jetty	4,
Aug. 2, 1882	......do	8,
	Total	78,

Entrance

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Notes:

Port Jefferson is a port of delivery in the collection district of New York. There is a light-house on Old Field Point, 1¼ miles west of the harbor entrance. Fort Hale, New Haven Harbor, Connecticut, 23 miles distant, is the nearest work of defense.

Money statement.

July 1, 1885, amount available	$475 06
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	90 70
July 1, 1886, amount available	384 36

COMMERCIAL STATISTICS.

The following facts, relating to commerce at Port Jefferson, are furnished by the surveyor of customs, forwarded through the collector at New York:

Chief articles of commerce: Wood, hay, and garden produce.

"There are about 3,000 tons of coal landed here in a year. Hundreds of yachts and coasting vessels put in here during the year for refuge. There is a steamer running from here to Bridgeport, making one and a half trips daily."

Sixty-seven vessels, net tonnage 6,415, are enrolled at this port.

D 19.

IMPROVEMENT OF FLUSHING BAY, NEW YORK.

Flushing Bay is on the north shore of Long Island, about 14 miles by water from the Battery at New York. The town of Flushing is on the east bank of Flushing Creek, a quarter of a mile from the head of the bay. The bay is about a mile wide and 2 miles long; the bottom is of soft mud, nearly level, the depth in the original channel being not much greater than elsewhere. In 1861 there was a depth of 5 feet at low water in the channel leading up to Flushing, and in 1879 but 3.9 feet. The mean rise of tide is 7.1 feet.

PROJECTS FOR IMPROVEMENT.

A survey of Flushing Bay was made in 1879, and a project for improvement was proposed and adopted, providing for the construction of dikes extending across the westerly part of the mouth of the bay and up on the west side of the channel to Flushing, in order to form a large tidal basin whose waters should ebb and flow through a narrow channel, with dredging to maintain a channel 6 feet deep at mean low water.

The estimated cost of carrying out this project was as follows:

Constructing 4,400 linear feet of pile-dike, at $10 per foot	$44,000
Constructing 7,800 linear feet of pile-dike, at $9 per foot	70,200
Constructing 900 linear feet of pile-dike, at $7.50 per foot	6,750
Constructing 3,600 linear feet of single piling, at $3.70 per foot	13,320
For 83,000 cubic yards dredging, at 20 cents per cubic yard	16,600
Contingencies	22,630
Total	173,500

All the timber work of the dikes was to be creosoted. Up to June 30, 1880, 3,057 linear feet of pile-dike were constructed on the west side of the channel from the head of the bay. Subsequent appropriations have been expended in dredging.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

No dredging nor dike construction was done, the available funds being insufficient. In August, 1885, 3 barrel beacons were placed on the dike to mark its position at extreme high water; cost, $120.50.

An examination of the bay was made in October, 1885.

PRESENT CONDITION OF IMPROVEMENT.

Of the proposed 16,700 linear feet of dike 3,057 feet have been built. The channels leading up the bay to the wharves have been twice dredged. At the time of the examination in October last they were in good condition, with an available depth of 6 feet.

PROPOSED OPERATIONS.

Until the dikes are completed dredging will be needed frequently, probably annually, to maintain the channel. If appropriations are made more than is urgently needed for dredging, it is proposed to continue the construction of dikes as provided for in the project.

Appropriations for improving Flushing Bay, New York, have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1879	Construction of dike	$20,000
June 14, 1880	Dredging	15,000
Mar. 3, 1881	......do	10,000
Aug. 2, 1882	......do	5,000
July 5, 1884	......do	10,000
	Total	60,000

Flushing Bay is in the collection district of New York. The nearest light-house is on North Brother Island. Fort Schuyler, New York Harbor, is the nearest work of defense.

Money statement.

July 1, 1885, amount available	$699 02
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	326 55
July 1, 1886, amount available	372 47
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,372 47
Amount (estimated) required for completion of existing project	103,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

For the following information concerning the commerce of Flushing I am indebted to the collector of customs at New York.

No record of arrival and departure of vessels is kept. The chief articles of commerce are coal, lumber, and general merchandise.

"Flushing Bay, situated opposite the eastern limits of the city of New York, is growing in commercial importance, owing to the needed facilities for the discharge of cargoes at New York, and may in the near future become an important adjunct thereto, forming a part of that port. The marine commercial business is transacted at New York. No approximate estimate of vessels visiting the bay can be given."

D 20.

IMPROVEMENT OF EAST CHESTER CREEK, NEW YORK.

East Chester Creek is a small tidal stream emptying into East Chester, or Pelham Bay. The bay is on the north shore of Long Island Sound, at its western end, being just east of Throg's Neck, and 20 miles by water from the Battery at New York. The mean rise of tide is 7.1 feet.

A reef of bowlders close to the course of vessels passing through the draw of Pelham Bridge (near the mouth of the creek) made the entrance dangerous. The depth for the first half mile, up to Goose Island, was rather over 7 feet at high water, from there to the Town Dock, 1½ miles from the mouth, the high-water depth was nearly the same, and from the Town Dock up to Lockwood's, 2¼ miles from the mouth, it was less than 7 feet.

PROJECTS FOR IMPROVEMENT.

The project for improvement, adopted in 1872, provided for making a channel 9 feet deep at high water from Pelham Bridge to a point about 3,000 feet above Lockwood's, a distance of about 3 miles, by removing bowlders and gravel from near the draw of Pelham Bridge; dredging a channel west of Goose Island, 125 feet wide and 1,500 feet long, and dredging a cut 100 feet wide and 1,000 feet long from the Town Dock up to the first bend; thence extending it by an easy curve through marsh and some rock cutting to Lockwood's, a stretch in which the natural bed of the stream was very winding; a cut 3,000 feet long, 100 feet wide, and 9 feet deep was to be made above Lockwood's to serve both as channel and tidal basin; the project also provided for diking parts of the channel. A modification of this project, submitted in 1873, consisted of proposed timber dikes, to confine the channel on both banks from above Town Dock to near Pelham Bridge; aggregate length 5,800 feet. The cost of the work was estimated as follows:

Basin, purchase of site, 18 acres, at $150	$2,700
Excavation to level of mean low water, 200,000 cubic yards, at 40 cents	80,000
Excavation of cut, 60,000 cubic yards, at 40 cents	24,000
Diking and revetting banks of cut	12,000
Engineering and contingencies	17,800
Total	136,500

The first work done under this project was in 1877. Since that time the channel through the marsh and rock just below Lockwood's has been made 100 feet wide and 9 feet deep at mean high water, the channel west of Goose Island has been dredged 125 feet wide and 9 feet deep at mean high water, the bowlders in the vicinity of Pelham Bridge draw have been removed, the channel just above and under the new draw-bridge on the Boston road at Lockwood's has been dredged out, a channel about 2,000 feet long and 9 feet deep at mean high water has been dredged from Pell Point up to Town Dock, the width being 40 to 45 feet, gradually increasing to 90 feet at Town Dock, and 1,235 linear feet of diking have been built.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The available funds were insufficient for resuming work, and nothing was done.

PRESENT CONDITION OF IMPROVEMENT.

There is now a depth of about 9 feet at mean high water in a narrow channel all the way up to Lockwood's; above that no work has been done.

PROPOSED OPERATIONS.

To complete the project there yet remains the widening of the channel to 100 feet and protecting it by construction of 4,565 feet of timber dikes; also the dredging of a tidal basin above Lockwood's, which can very properly be deferred until the improvements below are completed. About 30,000 cubic yards of dredging could be done and one-half of the proposed diking built conveniently in a single year at a cost of about $20,000.

Appropriations for improving East Chester Creek have been made as follows, viz:

Date.	Application.	Am
March 3, 1873	Cutting through marsh and rock and diking (in 1877)	$
March 3, 1875	Dredging under Boston Road Bridge and at Goose Island	1
June 18, 1878	Dredging near Lockwood's, Goose Island, and Pelham Bridge	1
March 3, 1879 June 14, 1880	Dredging 40-90 feet wide from Pell Point to Town Dock	
Total		5

East Chester Creek is in the collection district of New York. The nearest li house is on the Stepping Stones, 3 miles southeast of the mouth of the creek; nearest work of defense is Fort Schuyler, Throg's Neck, about 3¼ miles south.

COMMERCIAL STATISTICS.

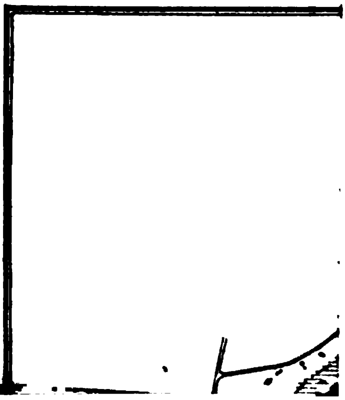
No record of arrivals and departures of vessels is kept, and it has been impractic to procure any accurate statement of commerce. Probably some 50 or 75 vessels c annually, bringing lumber, coal, and building materials.

No market produce is shipped from East Chester Creek.

Money statement.

July 1, 1885, amount available	$8
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3
July 1, 1886, amount available	4
Amount appropriated by act approved August 5, 1886	10,000
Amount available for fiscal year ending June 30, 1887	10,048
Amount (estimated) required for completion of existing project	72,500
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.



APPENDIX E.

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR.

REPORT OF LIEUTENANT-COLONEL WALTER McFARLAND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Hudson River, New York.
2. Harbor at Saugerties, New York.
3. Harbor at Rondout, New York.
4. Harlem River, New York.
5. Removing obstructions in East River and Hell Gate, New York.
6. Newtown Creek, New York.
7. Buttermilk Channel, New York.
8. Gowanus Bay, New York.
9. Gedney's Channel, New York.
10. Sheepshead Bay, New York.
11. Canarsie Bay, New York.
12. Sumpawanus Inlet, New York.
13. Manasquan River, New Jersey.
14. Shrewsbury River, New Jersey.
15. Harbor at Keyport, New Jersey.
16. Mattawan Creek, New Jersey.
17. Cheesequakes Creek, New Jersey.
18. Raritan Bay, New Jersey.
19. Raritan River, New Jersey.
20. South River, New Jersey.
21. Woodbridge Creek, New Jersey.
22. Rahway River, New Jersey.
23. Elizabeth River, New Jersey.
24. Channel between Staten Island and New Jersey.
25. Passaic River, New Jersey.

ENGINEER OFFICE, UNITED STATES ARMY,
New York, N. Y., October 20, 1886.

GENERAL: I have the honor to transmit herewith my annual reports upon the river and harbor works in my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

WALTER McFARLAND,
Lieut. Col. of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

E 1.

IMPROVEMENT OF THE HUDSON RIVER, NEW YORK.

My last annual report contained a history of this improvement, including original reports, accompanied by two sketches showing its present condition. This may be found in the Annual Report of the Chief of Engineers for 1885, Part I, page 677.

The only part of the Hudson River which has been improved is the stretch beginning at the head of navigation at Troy, N. Y., about 6 miles above Albany, and extending down the river to New Baltimore, about 14 miles below Albany, the total distance being a little over 20 miles by river.

While there has always been enough water below New Baltimore for navigation, this upper section of the river, so far as its history is known to us, has always been obstructed by bars and shoals, due to the existence of numerous islands and sloughs, and to the dispersion of the river water over too great an area.

Prior to 1831, when the jurisdiction of the Federal Government over these waters had been confirmed by judicial decision, the State of New York had made efforts to improve the navigation of this part of the river. Since 1831 the improvement of the Hudson River has been conducted both by the State of New York and by the General Government, both building and repairing dikes and doing such dredging as seemed necessary. In the last few years, however, the dike work has been left almost exclusively to the General Government, while the State of New York has done most of the dredging required.

The general system of improvement has been the same throughout, viz, the excavation of the channel by dredging and contracting the channel by jetties and dikes.

But prior to 1831, up to which time the work had been chiefly restricted to the construction of jetties and dredging, no permanent results had been obtained.

After 1831 the United States began the present general system of improvement by contracting the channel by means of longitudinal dikes, intended to aid in scouring the bars and shoals instead of using spur-jetties.

Under this system the United States constructed two dikes in 1835-'36-'37-'38.

Then followed a long interval of time in which nothing was done by the United States except in 1852; but in 1863 the State of New York took up the improvement on the general plan adopted by the United States in 1831, viz, substituting the system of longitudinal dikes instead of the jetty system, and between 1863 and 1867 built 6 important longitudinal dikes. (Annual Report of 1885, page 678.)

Out of the amount appropriated by act of Congress, approved June 28, 1864, the sum of $33,000 was allotted for the improvement of the Hudson River; and by act of Congress, approved June 23, 1866, the sum of $50,000 was appropriated for the improvement.

In April, 1866, Lieut. Col. (now Brig. Gen.) John Newton, Corps of Engineers, was placed in charge of the improvement, and remained in charge until the 1st of April, 1884.

In November, 1866, General Newton submitted a project for the improvement of the 20 miles of river between New Baltimore and Troy, which may be found in Annual Report of the Chief of Engineers for 1885, Part I, page 678; and, on the strength of his report, a systematic improvement of the river was begun and has been continued up to the present time.

The project was to secure a navigable channel 11 feet deep at mean low water from New Baltimore to Albany, and 9 feet deep at mean low water from Albany to Troy. The following description of it is taken from the report of the Board of Engineers March 5, 1880 (see Annual Report of the Chief of Engineers for 1885, Part I, page 690):

> First. A system of longitudinal dikes to confine the current sufficiently to allow the ebb and flow of the tidal current to keep the channel clear. These dikes to be

gradually brought nearer together from New Baltimore towards Troy, so as to assist the entrance of the flood current and increase its height, their height to be kept approximately at the level of the tidal high water so as not to confine the freshets, the exact level, however, being left to be determined by experience as the work progresses.

Second. That the dredge be used so far as necessary to open the channels above described, which the current should not be allowed to do, except very gradually lest accumulations dangerous to navigation be formed below.

Third. Keeping, as far as practicable, the side reservoirs open to the passage of tidal currents by gaps at their lower extremities in order to increase the tidal flow.

Fourth. Dumping all dredged materials in secure places, where it cannot be moved back into the channel by the current.

Fifth. Constructing the dikes of timber and stone, in a manner to secure their permanency, at a minimum cost, the details varying with the locality, to be left to the discretion of the local engineer, to be so designed as to admit of having an increased height given to the dikes, if necessary.

Sixth. To protect, when necessary, the banks and islands against the abrading action of the current's revetments.

Seventh. That limits, beyond which no encroachments upon the channel should be made, be prescribed, and that any such encroachments be reported to the engineer in charge.

The estimated cost of the improvement was $862,297.75, but after more reliable data had been obtained, in 1866 and 1867, a second estimate was made increasing the estimate $122,006.72, making the total estimated cost $984,304.47. This estimate was again increased in 1882 by $78,000, for the completion of existing works, a large amount of the appropriation intended for construction having been spent on repairs; and again in 1884 by $16,000, for the removal of a hitherto unknown rock in the overslough channel at Van Wie's Point, which brought the total estimate up to $1,078,304.47, although the amounts given in the annual reports, as the estimated cost of the improvement from 1868 to 1881, have been erroneously printed $984,304.47, and from 1882 to 1886 as $1,062,304.47.

Of this amount $1,027,288 had been appropriated up to June 30, 1885, when the available channel depth between New Baltimore and Albany was 10 feet, except at one point, Beacon Island, where there was a depth of 8.8 feet; and 8 feet could be carried from Albany to Troy except at Coville's Folly and Patroon's Island, where there were 7.8 and 7.5 feet respectively at low water.

These bars it has been reported have been subsequently dredged by the State of New York.

The gradual and steady increase in the navigable depths obtained during the improvement of the Hudson River are very marked.

In 1819 the available channel depth between New Baltimore and Albany was 4 feet at mean low water; in 1867 it was 7½ feet; in 1878 and 1879 it was 8½ feet; in 1885, 10 feet, except at the spot mentioned, which was subsequently dredged by the State. A table showing the depths from 1819 to 1879 may be found on page 691, Annual Report of the Chief of Engineers for 1885.

The improvement, as was originally expected, has also changed the tides of the Hudson.

In the report of the Board of Engineers March 5, 1880 (Annual Report of the Chief of Engineers for 1885, page 691), is stated:

> The tidal rise of the upper portion of the Hudson was many years ago 1.2 feet at Troy, 2.3 feet at Albany, and 3.7 at New Baltimore. The project of improvement adopted aims at increasing the tidal rise above New Baltimore, so as to gain, if possible, 1 foot at each of the places named. By doing so the rise will be lengthened, the ebb shortened, and the depth improved.

On the next page of the report (692) is stated:

Tidal observations [presumably in 1880] give—

	Feet.
At New Baltimore a rise of	3.43
At Coeymans (1.7 miles above) a rise of	2.86
At Castleton (4 miles above Coeymans) a rise of	2.55
At Albany (9 miles above Castleton) a rise of	2.32
At Troy (5 miles above Albany) a rise of	2.00

No work in the river has been done by the United States since 1884, except to make a complete survey from Troy to New Baltimore, the report on which may be found in last year's Annual Report.

The work remaining to be done under the original project is: The completion of the dike from Staats to Campbell's Island Dike, and from Schermerhorn Island to Shad Island; the proposed improvement between Shad Island and Mull's Plaat, New Baltimore; the improvement at Willow Island; the construction of a new dike to complete the line below Nine-Mile Tree, the extension of the dike at Mull's Plaat, and the removal of overslough rock at Van Wie's Point.

The estimated cost of the completion of these works, by General Newton, in 1882, was $78,000, exclusive of the overslough rock, which was estimated in 1884 to cost $16,000, making a total required for the completion of the project of $94,000.

The act approved August 5, 1886, reads, "Improving the Hudson River, New York, for continuing the improvements, $26,250, of which $15,000 may be used for a rock in the channel at Van Wie's Point"; which amount, with the $30,000 appropriation of July 5, 1884, makes a total amount available for the present fiscal year of $56,250.

But the dikes are in such a dilapidated condition in many places that the whole of this amount will have to be applied to the repair of existing works instead of beginning new ones.

In addition to this amount yet to be expended, more than $35,000 have been already expended up to the present time upon repairs of the works; so that really over $91,000 out of the total appropriations intended for original construction will have been necessarily expended on repairs of existing works when the present money available is spent, and this amount properly belongs to the construction fund yet to be appropriated.

It is recommended that the amount of $78,000, estimated for the completion of the project in 1882, by General Newton, be appropriated, and also the $16,000, estimated to be required for the removal of the rock at Van Wie's Point; making a total of $94,000.

COMMERCIAL STATISTICS.

Value of imports for the fiscal year ending June 30, 1886	$490,103 00
Duties collected thereon	85,862 21
There are enrolled and licensed at this port vessels with a tonnage of	68,696 76

AMOUNTS APPROPRIATED.

Date.	Amount.	Date.	Amount.	Date.	Amount.
June 28, 1864	$33,000 00	June 23, 1874	$40,000 00	By act approved.	
June 23, 1866	50,000 00	March 3, 1875	40,000 00	July 5, 1884	$30,000 00
March 3, 1867	305,188 00	August 14, 1876	50,000 00	August 5, 1886	26,250 00
July 25, 1868	85,000 00	June 18, 1878	70,000 00		
April 10, 1869	80,100 00	March 3, 1879	30,000 00	Total	1,053,538 00
July 11, 1870	40,000 00	June 14, 1880	20,000 00	Amount expended to close of fiscal year ending June 30, 1886	
March 3, 1871	40,000 00	March 3, 1881	15,000 00		
June 10, 1872	40,000 00	By act passed.			
March 3, 1873	40,000 00	August 2, 1882	10,000 00		998,886 [illegible]

Money statement.

July 1, 1885, amount available	$31,570 74
Received from sales of fuel	39 36
	31,610 10
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,091 70
July 1, 1886, amount available	28,518 40
Amount appropriated by act approved August 5, 1886	26,250 00
Amount available for fiscal year ending June 30, 1887	54,768 40
Amount (estimated) required for completion of existing project	94,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 2.

IMPROVEMENT OF SAUGERTIES HARBOR, NEW YORK.

The harbor of Saugerties is on the west bank of the Hudson River, about 95 miles above New York, and is formed by the mouth of Esopus Creek. Some works of improvement have already been attempted by the inhabitants, but no permanent benefit has been derived from them. In 1883 a survey with a view to its improvement, ordered by act of Congress passed August 2, 1882, was made under direction of General Newton, whose report, dated November 28, 1883, may be found in the Annual Report of the Chief of Engineers for 1884, Part I, page 716.

This report shows that the mouth of the creek is obstructed by a bar 1,100 feet long, lying between the 6-foot curve in the Hudson and the 6-foot curve in the creek, with a minimum depth upon it of 3 feet at mean low water.

Two projects for the improvement of this harbor were submitted, both providing for a channel 7 feet deep at mean low water and 100 feet wide, to be obtained by constructing parallel dikes and by dredging a channel between them; but the question which method would best accomplish the purpose was to be left until further examination could be made.

A sketch showing the two plans proposed was printed in Senate Ex. Doc. No. 57, Forty-eighth Congress, first session.

The estimates were as follows:

FIRST PLAN.

20,628* cubic yards at 35 cents	$7,219 80
North dike, 2,100 feet long, at $8	16,800 00
South dike, 2,800 feet long, at $8	22,400 00
Total	46,419 80

SECOND PLAN.

Dredging a channel 2,500 feet long, 100 feet wide, and 7 feet deep at mean low water, 55,654 cubic yards, *in situ.*, at 25 cents	$13,913 50
North dike, 2,600 feet, at $8	22,800 00
South dike, 800 feet, at $8	6,400 00
Total	43,113 50

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* Erroneously stated in original report to be $5,338.28.

The act of Congress approved July 5, 1884, appropriated $5,000 for the improvement of this harbor; but in view of the fact that the State of New York had undertaken to make some improvements there, it was decided not to begin work at once, but to wait until a further examination was made, and until it could be ascertained what plan of improvement had been decided upon by the State authorities.

By act of Congress approved August 5, 1886, the United States appropriated a further sum of $15,000 for this work; making the total amount available $19,955.95.

During the past year the State authorities have excavated 29,000 cubic yards of material from the bar at the mouth of the creek, giving a channel 8 feet deep at mean low water and about 200 feet wide from the 8-foot curve in the Hudson River across the bar to the 8-foot curve inside the mouth of the creek.

This channel, however, leads directly out into the Hudson, at right angles to the shore line, and across the lines of both the north dikes proposed by General Newton, which both run in a gradual curve downstream, on the same general principle of construction as the Rondout dikes. It may, therefore, be necessary to first apply the available funds to beginning one of the proposed south dikes, after further examination determines which of them it is best to adopt.

A carefully prepared statement of the commerce of Saugerties may be found on page 717, Part I, Report of the Chief of Engineers for 1883, since which date none has been received.

This work is in the collection district of Albany, N. Y., which is the nearest port of entry. The nearest light-house is at the mouth of Esopus Creek.

Amount appropriated	$20,000 00
Amount expended	44 05

Money statement.

July 1, 1885, amount available	$ 4,955 95
July 1, 1886, amount available	4,955 95
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	19,955 95
Amount (estimated) required for completion of existing project	26,419 60
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 3.

IMPROVEMENT OF THE HARBOR AT RONDOUT, NEW YORK.

Rondout Harbor is at the mouth of Rondout Creek, on the west bank of the Hudson River, between 80 and 90 miles above New York. The creek is a tidal stream for 3 miles above its mouth. Prior to 1871 improvements had been made by private persons and corporations, but no permanent benefits had been derived from them. A survey of the harbor was made by the Government in 1869, erroneously printed in last year's report to be 1871, with a view to its permanent improvement when it was found that there was an available depth of about 7 feet in the channel. The project based upon this survey provided for the formation and maintenance of a channel at the mouth of the creek 100 feet wide and 14 feet deep, to be obtained by means of dredging and diking. Two parallel channel dikes were to be built outward toward and into the Hudson on a gentle curve down-stream, with a branch dike running upstream along the Hudson from the outer end of the north dike to protect it from running ice. The estimated cost of this work was as follows:

Building the north dike, 748 yards long	$41,600 00
Building the branch dike, 640 yards long	34,400 00
Building the south dike, 1,277 yards long	59,600 00
Dredging a channel 3,000 feet long, 100 feet wide, and 14 feet deep at low water, 48,000 cubic yards, at 30 cents	14,400 00
Contingencies	22,500 00
Total	172,500 00

The final length of the north and south dikes was, however, to be determined by the effects which they produced in the removal of the bar as they were gradually extended outward. In 1872, by reason of a reduction in the estimated length of the dikes, their estimated cost was reduced to $104,000. The project was essentially completed in 1880, and a history of the improvement with sketches may be found in the Report of the Chief of Engineers for 1881, Part I, page 494.

At that date the north dike was about 2,200 feet long, the branch dike running up the Hudson was about 1,000 feet long, the south dike was about 2,800 feet long, with a spur to the light-house 330 feet long, and a depth of 13½ feet at low water had been obtained between the dikes.

The appropriation of $2,000 approved August 2, 1882, was applied to repairs. The dikes were refilled with stone where needed, fender-piles were placed at the outer end of the north dike, and 600 feet of the south dike was raised to the level of high water. The balance of this appropriation available July 1, 1884, was $706.03, which, with the appropriation of $1,000, approved July 5, 1884, was applied to cutting off 150 feet of the outer end of the south dike, and to dredging the channel and putting spring-piles along the dike.

Although the project was practically completed, it was stated in my last Annual Report that the $10,000 still to be appropriated under the original estimate could be profitably expended in repairing the dikes and in widening the channel between them.

Of this amount $2,500 was appropriated by act approved August 5, 1886, leaving a balance of $7,500 still to be appropriated.

This amount will be applied to dredging and repairing the dikes, if necessary.

Appropriations for the improvement of Rondout Harbor have been made as follows:

By act approved June 10, 1872	$10,000 00
By act approved March 3, 1873	20,000 00
Amount allotted June 8, 1875:	
From repairs of harbors on Atlantic coast	762 18
From contingencies of rivers and harbors, &c	237 82
By act approved August 14, 1876	30,000 00
By act approved June 18, 1878	30,000 00
By act passed August 2, 1882	2,000 00
By act approved July 5, 1884	1,000 00
By act approved August 5, 1886	2,500 00
Total	96,500 00
Amount expended	93,939 64

In the original report upon this harbor in 1869 (see Annual Report of Chief of Engineers for 1869, page 394) it is stated "the amount of commerce and navigation to be benefited by the improvement of navigation would be annually from $70,000,000 to $80,000,000. This is as near as could be estimated from the data available."

No statement of commerce has been received since this date; and when it has been asked for, reference has been made to this statement.

Rondout is the headquarters of the largest cement works in this country. It is also the principal summer shipping point of the Delaware and Hudson Canal Company's coal on the Hudson River.

The effect of this improvement has been to allow vessels to pass up to and down from the wharves at Rondout, without having to lighter in and out over the bar, as was the case formerly.

Rondout is in the collection district of New York. The nearest works of defense are those of New York Harbor. Amount of revenue collected at the port of New York during the fiscal year ending June 30, 1886, $132,536,402.02.

Money statement.

July 1, 1885, amount available	$60 36
July 1, 1886, amount available	60 36
Amount appropriated by act approved August 5, 1886	2,500 00
Amount available for fiscal year ending June 30, 1887	2,560 36
Amount (estimated) required for completion of existing project	7,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 4.

IMPROVEMENT OF THE HARLEM RIVER, NEW YORK.

No work has been done on this improvement during the past year, and its history is somewhat as follows:

Congress, by the second section of "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," approved June 23, 1874, directed that the Secretary of War should "cause examinations or surveys, or both, to be made," among other places, "at Harlem River, from Randall's Island, by way of Spuyten Duyvil Creek, to Hudson River, New York."

This survey was, by direction of the Chief of Engineers, placed in charge of Lieut. Col. (now Brig. Gen.) John Newton, Corps of Engineers, whose report, dated February 18, 1875, was published in House Ex. Doc. No. 75, Part 9, second session Forty-second Congress, and is to be found at page 224 of the Annual Report of the Chief of Engineers for 1875, Part II.

A supplementary report, made February 10, 1876, is printed in the Annual Report of the Chief of Engineers for 1876, Part I, page 246.

The act of Congress relating to rivers and harbors approved March 3, 1881, provided also, among other things, for "completing survey of Harlem River and through the Harlem Kills to the East River, New York." The report on this survey was made by General Newton under date of October 8, 1881, and is to be found in the Report of the Chief of Engineers for 1882, Part I, page 656.

The difficult point in the improvement of the Harlem River is the connection of that river with the Hudson; Spuyten Duyvil Creek, which forms the natural water connection, being both narrow and crooked. General Newton's survey covered four lines along which this connection might be made.

1. By way of Sherman's Creek to Inwood or Tubby Hook, on the Hudson.
2. From Sherman's Creek to a bend of Spuyten Duyvil Creek, near Johnson's Foundry.
3. By a cut through Dyckman's Meadows to the Spuyten Duyvil.
4. Through Spuyten Duyvil Creek by way of Kingsbridge.

The estimates of cost showed that the route by way of a cut through Dyckman's Meadows would be the least expensive, and that route was accordingly recommended. The proposed lines of improvement, as laid down by the engineer in charge in his annual report for 1882, are as follows:

(1) Below the Harlem or Third Avenue Bridge the outer pier and bulkhead lines, as laid down by the park department, are adopted.

(2) Above the Third Avenue Bridge to the entrance of Dyckman's Cut into the Harlem River the exterior pier and bulkhead lines are laid down 400 feet apart.

(3) The line following Dyckman's Cut through Dyckman's Meadows will pass for a part of the way through solid rock; and it is here that the principal cost of the undertaking must be encountered. This part is to be made 350 feet wide. It would have been preferable to establish it at 400 feet, but the additional amount of rock excavation was the obstacle.

(4) The remainder of the line to the Hudson River will follow as nearly as possible the course of the Spuyten Duyvil, and the width will be 400 feet.

As the difference in the heights and times of tides between the East and North rivers after the connection is made between the Harlem and the Hudson will be the cause of the currents upon which reliance is placed to keep open the channel, it is desirable that the cross-section of the channel be kept as uniform as possible in order to avoid the unnecessary resistances to the flow of the water which would be caused by any contraction of the water-way.

The contraction of the proposed cut through Dyckman's Meadows will be more than counterbalanced by the natural channel through Spuyten Duyvil by the way of Kingsbridge, which is left open; and the contraction caused by the piers and embankments of the High Bridge, which carries the Croton aqueduct across the Harlem River, should be counteracted by deepening the channels between the piers and abutments. Observations of the tides affecting these waters show that there is not a free exchange of tides between Harlem River and Spuyten Duyvil Creek, but that there is practically a divide somewhere near Fordham Bridge between the tides flowing from the East River into the Harlem River, and from the Hudson River into Spuyten Duyvil Creek. Comparing the tides of the Harlem River at Fordham Bridge with those of the Hudson River at the mouth of Spuyten Duyvil Creek, it is found:

(1) That the level of mean high water in the Hudson is nearly 1 foot (.961) lower than it is in the Harlem.

(2) That the mean rise and fall of the tide in the Hudson is 2.12 feet less than it is in the Harlem.

(3) That the mean duration of the rise of tides in the Hudson is 36 minutes shorter, the mean duration of the fall 36 minutes longer, and the mean duration of slackwater 20 minutes longer than in the Harlem.

(4) The mean level of the Hudson at the mouth of Spuyten Duyvil Creek is .265 of a foot lower than at Fordham Bridge.

(5) High water occurs 1 hour and 34 minutes earlier in the Hudson than in the Harlem.

From these facts it follows that while there will at different times be a flow towards either river, the preponderance of flow will be towards the Hudson; and the scour will go that way, so that, if a cut for the free passage of the tides be made, the opening into the Hudson will become the mouth of the cut.

The estimated cost of making the connection by a cut through Dyckman's Meadows, as given by General Newton in his report for 1882, is $2,100,000.

This estimate does not provide for the improvement of the channel of the Harlem River between this proposed cut and the mouth of the Harlem River.

The estimated cost of improving this part of the river, as given in General Newton's report for 1875, was about $600,000. Total for the improvement of the Harlem River between the Hudson and the East rivers, $2,700,000.

The estimated cost of opening the channel from the Harlem River to the East River by way of the Harlem Kills, making it 300 feet wide and 15 feet deep at low water, was about $2,200,000. This survey was ordered by act of Congress approved March 3, 1881, and the report upon it is to be found in the Annual Report of the Chief of Engineers for 1882, Part I, page 656.

By act of Congress relating to river and harbor improvements, approved June 18, 1878, there was appropriated "for the improvement of Harlem River, New York, $300,000; but this sum is not to be available until the right of way for this work is secured to the United States, free of cost"; and by act approved March 3, 1879, there was appropriated "for improving Harlem River, New York, $100,000; but this appropriation is made subject to the provisions and limitations contained in the act of June 18, 1878, relating to said Harlem River improvement and the right of way therefor."

As under the restrictions of these two appropriations no part of them could be expended towards beginning this improvement until the right of way was secured to the United States without cost, an allotment was made from the appropriations for "Examinations, surveys, and contingencies of rivers and harbors" for the purpose of making surveys to ascertain whose lands would be crossed or touched upon by the proposed work; and, this being done, letters were addressed by General Newton to the various property-holders concerned, asking if they would cede to the United States the land needed for the purposes of this improvement. As very few signified their willingness to do so, measures were taken by persons interested in the improvement to have a bill introduced in the New York State legislature to provide for appointing a commission to assess benefits and damages, and to condemn such land as may be necessary for the proposed work.

This bill having become a law, detailed maps and descriptions of each piece of property to be affected by the proposed work were prepared for submission to the Supreme Court of the State, this step being necessary before commissioners could be appointed. In October, 1879, three commissioners were appointed by the Supreme Court for this purpose; but they had not proceeded far with their work when they found it necessary to apply to the legislature for increased powers to enable them to more efficiently discharge their duties. Their report was completed and was presented to the Supreme Court in 1882, where final action is to be taken. Great opposition to the recommendation of the commissioners has been made by some of the property-owners affected, and efforts are being made to have the original act under which the assessments are made revoked by the State legislature.

The beginning of this improvement awaits, as it has for the last eight years, the settlement of this question.

This work is in the collection district of New York. Nearest port of entry, New York City. Nearest light-house, Blackwell's Island Light.

Amount of revenue collected at the port of New York during the fiscal year ending June 30, 1886, $132,536,402.02.

Money statement.

July 1, 1885, amount available	$400,000
July 1, 1886, amount available	400,000
Amount available for fiscal year ending June 30, 1887	400,000
Amount (estimated) required for completion of existing project	2,300,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 5.

REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE, NEW YORK.

The charge of this improvement was retained by General Newton, with Lieutenant-Colonel McFarland and Lieutenant Derby as assistants, until the last day of December, 1885, when it was transferred by him to Lieut. Col. Walter McFarland, Corps of Engineers. General Newton's annual report gives in detail the operations on Flood Rock, Hell Gate, up to the date of the final explosion October 10, 1885. The operations subsequent to that date will be reported upon here, although partly occurring during General Newton's charge.

Owing to the economy effected in the cost of the final blast, chiefly by the substitution of rackarock for Dynamite No. 1, a balance of upwards of $100,000 remained on hand from the appropriation of July 5, 1884, and specifications for the removal of so much of the débris of the reef as these limited funds would permit were drawn up and the work was advertised at once.

The total amount of broken rock to be removed from the reef to give the depth of 26 feet at mean low water, called for by the present project of improvement, is estimated to be about 294,000 tons. The funds available were sufficient only for the removal of about 30,000 tons, a little more than one-tenth of the whole. This was not enough to produce a depth of 26 feet over any part of the reef of sufficient width to be of any immediate benefit to navigation, as it is impracticable to work upon the eastern side of the reef adjoining the eastern channel, which is now the most used and has become the main channel, because that channel is overcrowded with passing traffic, and the strongest tide in Hell Gate runs with great violence across that part of the reef.

It was therefore thought advisable to adopt the suggestion of Lieutenant Derby and to expend the available funds in dredging the dangerous reefs known as the Negro Heads and Hen and Chickens to a depth of 18 feet at mean low water, and to cut off to the same depth a spur projecting from the northwest side of Flood Rock proper. Under this application of the funds it would be possible to obtain a through channel between Flood Rock and Mill Rock of nearly, if not quite, the same width between the 18-foot contour as the present eastern or main channel (400 feet), and of a depth sufficient for nine-tenths of the vessels passing through Hell Gate.

After the completion of this channel the main body of the reef can be advantageously removed to the proposed depth of 26 feet by starting on the eastern side of the 18-foot channel and working over gradually toward the eastern or main channel, so that by the time the latter is reached its currents will have been so far reduced and the navigation of Hell Gate so far simplified as to make it comparatively safe for the dredges to work where they cannot work at all at present.

The bids for the work on the 18-foot channel were opened October 21, 1885, and the contract was awarded to the Atlantic Dredging Company, of Brooklyn.

The contractor began work November 4. He has done his work with great energy and good judgment, and at the close of the fiscal year had removed 28,622 tons. The contract was subsequently completed, and a good 18-foot channel from 350 to 400 feet wide was secured between Flood Rock and the Mill Rocks. The 12-foot channel was 150 feet wider than this.

The following is a detailed statement of the work done up to June 30, 1886:

Number of machine.	Number of days worked.	Number of days worked double.	Number of hours worked.	Number of surface blasts fired.	Pounds of dynamite fired.	Number of tons of broken rock raised.	Number of tons raised per day worked.	Cost of surface blasting per ton raised.
I. Packard's No. 6	159	33	1,507[illegible]	97	8,280	15,585.820	81.17	$0.110
II. Packard's No. 5	14	......	96[illegible]	3	190[illegible]	500.067	35.72	0.079
III. Morris & Cummings's No. 6.	151	......	1,337[illegible]	75	4,118[illegible]	7,695.258	50.96	0.112
IV. Ross & Sanford, No. 6	98	26	1,009[illegible]	84	5,700	4,841.167	39.04	0.2[illegible]
Total	422	59	3,950[illegible]	259	18,288[illegible]	28,622.312	....	0.134

The cost of the surface blasting, which was done by the contractor, is extremely small, averaging only 13 cents per ton, and shows that this item does not deserve nearly the consideration it has received heretofore. It is interesting to note that the dredge numbered 1 in the above table, which is the same machine that did the bulk of the work of removing Hallet's Point, has averaged 81.2 tons per day, whereas the records show that her average for the first six months on Hallet's Point was only 50.4 tons, indicating that the rock is better broken up at Flood Rock than it was at Hallet's Point. Considering the low cost of the surface blasting, which had been previously regarded as a doubtful element, it is apparent that future contracts on Flood Rock should be let at very much reduced prices.

The accompanying Table II shows the amount and cost of the work done at Flood Rock during the fiscal year ending June 30, 1886.

Great difficulty having been experienced at Hallet's Point in keeping the dredges from working too deep in some places, and leaving projections above the bottom in others, the inspection of the contractor's work on Flood Rock has been conducted with great care, 7,188 soundings having been taken and platted, and each cut made by the dredges having been repeatedly examined with the horizontal sweep. As work of this character in Hell Gate is fraught with difficulties, great credit is due to Lieutenant Derby and his assistants, G. W. Kuehnle and J. M. Gore, surveyors, for the skill and energy with which they conducted this work.

Complete surveys have also been made during the year of the whole of Flood Rock Reef immediately after the blast, and of Heel Tap, and preparations have been made for surveying Frying Pan and Pot Rock, neither of which reefs has been examined since the last work was done upon them by the drill-scow some years ago.

Since March 1 a continuous record of the tides has been kept with the self-registering tide-gauge, and those observations are now being reduced.

All the buildings and the plant used in the mining operations at Flood Rock, which were hurriedly brought over to Astoria just before the explosion, have been carefully assorted and stored, but on account of the dampness of the atmosphere in that vicinity the machinery requires constant attention to keep it from deteriorating.

The accompanying Table III shows the amount and cost of the work done by the United States steam drill-scow during the fiscal year.

As the appropriation of July 5, 1884, was limited in its application to work on Flood Rock, the Drill Scow has remained idle at her berth at Mill Rock throughout the whole year, with the exception of a period of thirty-four days immediately after the blast at the Flood Rock, when she was employed in raising broken stone from the reef by means of divers and sling chains. This work was discontinued December 1, at the beginning of freezing weather, and has not been resumed this season, the contractor having occupied all the available space on the reef with his dredges.

Broken rock cannot be picked up by divers in Hell Gate for much less than $2.50 per ton, and, from the progress made by the contractor's dredges so far, it is probable that the next contract will be let at a price considerably below this. It will, therefore, not be profitable to employ the drill-scow on Flood Rock again until the dredges have progressed so far as to have reduced the reef generally to a depth of 26 feet and over, when divers can be employed to good advantage in removing the small projecting points of rock left behind by the dredges, which these machines cannot pick up without raising a large amount of neighboring rock and thus adding unnecessarily to the cost of the work.

In the meanwhile it is to be hoped that future appropriations will admit of the drill-scows being used for the purpose for which she was designed on the other Hell Gate Reefs, as the cost of maintaining her in order while idle is considerable.

The work is in the collection district of New York. The nearest port of entry is New York City. The amount of revenue collected during the year ending June 30, 1886, $132,536,402.02. The amount of commerce and navigation benefited by the completion of this work, about $4,000,000 daily.

ORIGINAL ESTIMATE.

Removing reefs at Hell Gate and Diamond and Coenties reefs, $5,139, 120.

AMOUNT APPROPRIATED.

Date of act.	Amount.	Date of act.	Amount.
July 25, 1868	$85,000 00	July 5, 1884	$360,000 00
April 10, 1869	178,800 00	August 5, 1886	112,500 00
July 11, 1870	250,000 00	Received from other sources	3,167 13
March 3, 1871	250,000 00		
June 10, 1872	225,000 00		3,664,467 13
March 3, 1873	225,000 00	Deduct amount reverted to United States Treasury $3,158 55	
June 23, 1874	225,000 00		
March 3, 1875	250,000 00		
August 14, 1876	250,000 00	Deduct amount allotted to Harlem River 11,000 00	
June 18, 1878	350,000 00		
March 3, 1879	250,000 00		14,158 55
June 14, 1880	200,000 00		
March 3, 1881	200,000 00		3,650,308 58
May 4, 1882	50,000 00		
*August 2, 1882	200,000 00	Amount expended to date	3,467,331 88

* Date of passage.

Amounts expended during the year ending June 30, 1886:

Flood Rock	$198,437 23
Steam drilling-scow	7,618 60
	206,055 83

Money statement.

July 1, 1885, amount available		$267,949 74
Received from sales of fuel		29 25
		267,978 99
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$197,502 30	
July 1, 1886, outstanding liabilities	29,828 35	
		227,330 65
July 1, 1886, amount available		40,648 34
Amount appropriated by act approved August 5, 1886		112,500 00
Amount available for fiscal year ending June 30, 1887		153,148 34
Amount (estimated) required for completion of existing project		1,488,840 67
Amount that can be profitably expended in fiscal year ending June 30, 1888		500,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for removing broken rock from Flood Rock Reef, Hell Gate, New York, opened October 21, 1885.

No.	Name and address of bidders.	Price per ton.	Cost of 30,000 tons.
1	The American Dredging Company, Philadelphia, Pa	$3 90	$117,000 00
2	P. Sandford Ross, Jersey City, N. J	3 48	104,400 00
3	The Harbor Improvement Company, New York, N. Y	3 49	104,700 00
4	Morris & Cummings Dredging Company, New York, N. Y	3 38	101,400 00
5	Atlantic Dredging Company, Brooklyn, N. Y	3 19	95,700 00

The contract was awarded to the Atlantic Dredging Company.

TABLE II.

Tabulated statement of the amount and cost of work done at Flood Rock, Hell Gate, East River, New York, for fiscal year ending June 30, 1886.

Work, &c.	Number of shifts of eight hours worked.	Number of tons of broken rock removed.	Cost of materials.	Cost of wages.	Cost of removing broken rock.	Total cost.
		Tons.				
Pumping	533.625		$2,141 39	$1,409 22		$3,550 61
Final blast	4,789.875		87,981 37	13,909 92		101,891 29
Care of plant	2,640.125		1,805 90	5,802 70		7,608 60
Removal of broken rock by hired labor	911.875	558.1	397 85	1,964 36		2,362 21
Removal of broken rock under contract		28,622.312			$91,305 04	91,305 04
Inspection and resurvey	1,589.5		267 10	5,266 04		5,538 14
Superintendence and office expenses	1,678.125		1,280 73	7,351 90		8,632 63
Total	12,092.125	29,180.412	93,874 34	35,704 14	91,305 04	220,883 52

Of the expenses here reported there are liabilities aggregating $29,805.81 outstanding June 30.

The entire cost of the final blast, including pumping, and expenditures made during fiscal year 1885, is $111,248.

TABLE III.

Tabulated statement of the amount and cost of work done by the United States steam drill-scow for the fiscal year ending June 30, 1886.

Work, &c.	Number of shifts of eight hours worked.	Number of tons of rock removed.	Cost of materials.	Cost of wages.	Total cost.
		Tons.			
Experiments with grapple			$105 00		$105 00
Additions to plant			1,044 46		1,044 46
Examination of reef after final blast	55			$105 00	*105 00
Removing broken rock from Flood Rock	911.875	558.1	397 85	1,964 36	*2,362 21
Materials on hand			650 65		650 65
Maintenance while idle	993.25		311 81	2,802 93	3,114 74
Total	1,959.625	558.1	2,509 77	4,872 29	7,382 06

* Charged to Flood Rock.

Of the expenses here reported there are liabilities aggregating $22.54 outstanding June 30.

COMMERCIAL STATISTICS.

Value of imports, exports, and duties collected at port of New York.

Year ending June 30—	Imports.	Exports.		Duties.
		Domestic.	Foreign.	
1883	$508,700,476	$362,571,653	$21,166,859	$146,581,223 14
1884	486,355,355	363,055,394	21,557,810	133,866,902 91
1885	406,035,435	349,939,225	17,828,096	125,313,677 43

Tabulated statement of the commerce of the port of New York.

Year.	VESSELS ENTERED.					
	American.		Foreign.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
1883	1,900	1,085,078	4,352	5,413,159	6,252	6,448,[illegible]
1884	1,869	1,006,556	4,197	4,652,315	6,066	5,658,[illegible]
1885	1,691	930,444	4,133	4,729,289	5,824	5,65[illegible]

Year.	VESSELS CLEARED.					
	American.		Foreign.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
1883	1,501	904,272	4,376	5,423,418	5,879	6,327,[illegible]
1884	1,442	839,762	4,094	4,584,196	5,538	5,42[illegible]
1885	1,278	770,109	4,031	4,670,615	5,304	5,44[illegible]

Number and tonnage of steam and sailing vessels, barges and canal-boats belonging to the port of New York.

Years.	Sailing vessels.		Steam vessels.		Barges.		Canal-boats.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1883	2,451	505,559.55	978	336,327.35	441	86,446.49	201	20,442.08	4,071	948,775.[illegible]
1884	2,488	512,401.33	1,044	361,438.82	454	90,715.19	209	21,196.78	4,195	985,752.[illegible]
1885	2,437	518,908.12	1,028	364,169.58	465	93,407.05	209	21,178.54	4,139	992,[illegible]

REPORT OF BRIGADIER-GENERAL JOHN NEWTON UPON REMOVAL OF FLOOD ROCK.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., August 25, 1886.

SIR: At the close of the last fiscal year the work of undermining Flood Rock and drilling the 3-inch holes for the reception of the charges for the final blast had been completed, and the work of cleaning up the four miles of galleries and making the final preparations for receiving the explosives and charging the mine was in progress; the contracts for the delivery of 240,399 pounds of rackarock and 48,537 pounds of dynamite had been executed with the Rendrock Powder Company and R. W. Warren, respectively; and the contract for the 58,337 copper cartridge-cases had been awarded the Rendrock Powder Company; but, owing to some misunderstanding as to the thickness of the metal to be used, this contract was not signed until July 16, 1885.

It had been decided to select rackarock as the principal explosive for the blast, on account of the absolute safety with which it could be stored; its greater safety in handling as compared with dynamite; its greater density (1.7 to 1.4), and its cheapness, the price bid being 23 cents per pound as against 43 cents, the lowest bid received for dynamite from companies having the facilities for furnishing the explosives in the quantities required.

The specifications required that the rackarock should have a strength only of 90 per cent. that of No. 1 dynamite when fired under water and measured by the method in use at the Engineer School of Application at Willets Point. But such care was taken by the contractors in selecting their materials and such benefits derived from the careful determination made at Willets Point experimentally, and from the analysis of the exact proportions of oil and chlorate to be used, as well as the thoroughness of the mixing of these ingredients, that the 71 samples tested showed an average strength of 109 per cent. that of dynamite No. 1, no sample falling below 99 per cent.

All of these tests, except the chemical analysis made by the chemist of the Rendrock Powder Company, were the personal work of Lieut. Col. H. L. Abbot, Corps of Engineers, commanding the Engineer School of Application, whose report is submitted herewith.

The reef to be destroyed consisted of the whole of the middle reef in Hell Gate, comprising Flood Rock proper and the reefs known as the Negro Heads, Hen and Chickens, and Gridiron. A narrow strip of Flood Rock was bare at high water, and isolated projections of other reefs mentioned were visible at low water. The present project of improvement contemplates making a depth of 26 feet at mean low water over the entire area occupied by the reef, which is about 9 acres. As it involved but little extra cost, however, the charge was so placed as to break the rock to a depth of 30 feet mean low water, so that, should the necessities of commerce demand this extra depth at any time, it can be obtained by dredging.

The method adopted for the removal of the reef consisted in sinking a shaft on the highest point and running a sufficient number of galleries from the foot of this shaft, under the reef, to enable charges of explosives to be so placed as to break up the whole reef at one blast.

This method is not considered an economical one for the removal of submarine reefs under ordinary circumstances. But in a crowded channel like Hell Gate, where the engineer must be prepared for constantly recurring collisions, working from the surface is beset with unusual difficulties and uncertainties; thus the Hell Gate drill-scow, designed for use on the smaller reefs whose location forbids the tunneling method, has been run into more than once with sufficient force to wreck the colliding vessel and to seriously cripple the drill-scow.

However, as each reef that is removed helps greatly to reduce the current and so to simplify navigation as to enable pilots to keep control of their vessels and avoid collisions, the uncertainty of doing economical work from the surface in Hell Gate is rapidly disappearing.

The total amount expended on Flood Rock from June 7, 1875, when the sinking of the shaft was commenced, to October 12, 1885, when all hands were paid off, is $1,061,983.18.

The distribution of this expenditure among the various branches of the work, and the amount of work done, are set forth in the accompanying tabular statements.

It is not practicable to run tunnels under the bed of a river through treacherous rock, keeping as *near* the water as possible, at the same cost as ordinary tunneling; but to show the improvement made in such work since the Hallet's Point explosion in 1876, it is only necessary to say that the total cost of breaking up the reef at Flood Rock per cubic yard of rock originally in the reef above the plane of 26 feet below mean low water is 56 per cent. less than the same item for Hallet's Point, and the total cost per cubic yard of rock actually broken is 65 per cent. less.

Work was commenced sinking the shaft at Flood Rock June 7, 1875, and the whole mine could have been completed in four years; but owing to the insufficiency of the appropriations, it was not finished until June 25, 1885.

The total amount of rock excavated from the mine was 80,231.94 cubic yards, and the total length of galleries driven, averaging 10 feet by 10 feet in cross-section, was 21,668.88 feet.

June 30, 1885, the force at the mine was reduced to a gang of 26 men, selected from amongst all the employés on the rolls, for the responsible duty of loading into the mine the 288,936 pounds of explosives required for the blast. It had been decided that safety could be best secured by limiting the amount of explosives to be loaded to about 6,000 pounds per day, so as to avoid all haste and confusion and permit closer supervision.

The packing-rooms for loading the cartridges and preparing them to be taken down into the mine were located on a dike built by the United States between Great and Little Mill Rocks, about 1,000 feet from Flood Rock, and on board the United States steam-drill scow moored at the dock at Mill Rock.

As rackarock, which had been selected for the blast after a prolonged series of experiments, is absolutely inexplosive so long as its two ingredients are not mixed, the contract called for its delivery in large quantities of 100,000 pounds. The first shipment was received July 22, and stored, the chlorate of potash in sheds at one end of the dike, and the di-nitro-benzol at the other, the mixing-house being about half way between them, convenient to the dock.

The danger of keeping large quantities of dynamite on hand within a few hundred yards of the tenement houses of a populous city like New York was duly appreciated, and the quantity to be delivered by the contractor was, therefore, limited to a week's supply, which was delivered sealed in copper cartridges, and stored under water in the river where the chances of an accidental explosion were a minimum, and where the results of such an accident, should one occur, would be reduced by the tamping of the water to local effects only. The contractor made his first delivery of dynamite July 29, and the first 2,500 cartridge-cases having been received July 25, on July 30 everything was in readiness to begin charging the mine. The process was as follows:

A keg of chlorate of potash was brought down from the storehouse at one end of the dike and 56 pounds weighed out and carried into the mixing-house, passed rapidly through a sieve, and spread out in a large lead-lined trough. At the same time a barrel of the di-nitro-benzol oil was tapped at the other end of the dike, 14¾ pounds weighed out and carried to the mixing-house and sprinkled with a large watering-can over the chlorate in the trough. The two ingredients were then thoroughly mixed by stirring with wooden hoes. The mixing requires but a few minutes' time, when the explosive is ready for use. It has the appearance of very light brown sugar, and a strong odor of bitter almonds.

From the mixing-trough the rackarock was passed to the small troughs of the packers, standing at a narrow table along one side of the mixing house, who rapidly packed it into the long copper cartridges intended for the mine.

These cartridges (Fig. 1), of which 44,175 were used, were 2 feet long and 2¼ inches in diameter, and were made of sheet-copper only 0.0[illegible] of inch thick and tinned on the inside. They were adopted, after extended experiment, as being the best possible envelope for the transmission of sympathetic explosions, and having stood well for three

FIG. 4

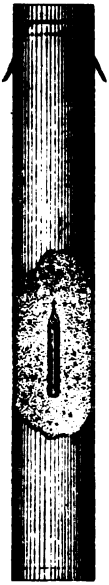


FIG. 1

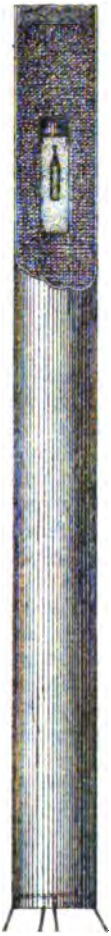
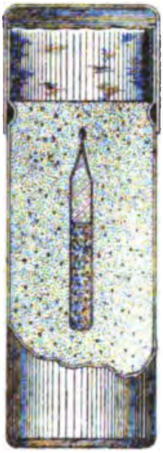


FIG. 2



months the action of sea-water on the outside and that of rackarock on the inside.

The tin cases used at Hallet's Point could not be used at Flood Rock, as they would not stand the exposure to the action of the salt water in the drill-holes for so long a period as that required to charge the mine. Owing to the extreme thinness of the copper used, however, the Flood Rock cartridges cost materially less than the tin ones. To assist in preventing the cartridges from sliding out of the drill-holes, nearly all of which opened downwards, four wire prongs (shown in Fig. 1) were soldered to their bottoms, which held the cartridge in place by pressing against the sides of the drill-holes. This device could not be relied upon altogether, however, experience at Hallet's Point having shown that it was liable to fail, on account of the breaking of the prongs, three cartridges having fallen to the ground in consequence. In all cases, therefore, the last cartridges put into the hole was solidly wedged in place with small pine wedges. Notwithstanding this precaution, however, one cartridge was dropped at Flood Rock. One of the miners, on leaving off work at night, having failed to securely wedge the mouth of the hole, the prongs on one of the cartridges gave way during the night, allowing it to slide out of the hole, and fall to the ground, a distance of about 10 feet. This was the only occurrence of the kind throughout the loading.

The rackarock was loaded into these cartridge-cases through a copper funnel and packed with a wooden rammer. When filled they contained about 5.72 pounds of rackarock. In addition a small primer, consisting of a thirty-grain fulminate cap and one ounce of No. 1 dynamite put loosely into a stout copper shell (Fig. 11), tightly corked and sealed, was buried in the rackarock about four inches from the end of the can. The office of this primer was to transmit the explosion throughout the length of the charge in the drill-holes, which in many cases were as much as 12 feet deep.

This method of securing the explosion of long, narrow charges of such inert explosives as rackarock was devised at Flood Rock, and its efficiency thoroughly tested by a complete series of experiments, which were reported at the close of the last fiscal year.

Without it rackarock would have been rejected at Flood Rock on account of the uncertainty of continuing the explosion to the bottom of the hole.

As fast as the cartridges could be filled they were thoroughly wiped off and passed across the mixing room to a table along the opposite wall, where their lids were securely soldered on by the use of a fusible alloy melting at 160° F., and a soldering-iron heated by a jet of exhaust steam to a temperature of 212°. As neither dynamite nor rackarock are exploded by a temperature less than 360°, a sufficient margin for safety was allowed.

This process was invented for the occasion at Flood Rock, the volatility of the nitro-benzol and its extremely penetrating character preventing the use of any other method of closure.

The tightness of the soldering of every cartridge was thoroughly tested, and the cartridges were then stood up in boxes divided into compartments, as shown in Fig. III. As fast as filled, these boxes, containing 20 cartridges, were carried out and delivered by the contractor's men to the inspector's gang aboard the drill-scow, who critically examined each cartridge, covered the solder on the lid with wax to protect it from the action of the salt water, and completed the contents of each box by adding six dynamite cartridges, described below, a suitable number of small pine wedges, and a bunch of tin tags corresponding in number with the cartridges in the box.

The dynamite cartridges, 14,162 of which were used, were 2¼ inches in diameter and 15 inches long (Fig. IV). They were packed by the contractor at his works at Tom's River, N. J., under the supervision of an inspector, and delivered at Mill Rock ready for use, except that into each one a 30-grain fulminate cap had to be inserted and the can resealed with wax. The object of this cap was to insure an explosion of the first order when the charge was fired by sympathy. The boxes of cartridges were loaded on a tug-boat four at a time, and taken over to Flood Rock, and lowered at once into the mine, and loaded into the drill-holes. In this way no considerable quantity of explosive was kept on hand anywhere above ground; so that, had an explosion occurred at any time, it would only have been sufficiently great to wreck the works, without spreading destruction through the upper part of New York, City and the village of Astoria.

The force of twenty men, in the mine, under the supervision of an overseer, was divided into three gangs, each in charge of a foreman, and each gang subdivided into squads of two men each; each squad worked by itself, and was composed of the same men throughout the season.

Every drill-hole in the mine had previously been located, plotted, and numbered by the surveying party, and the proper charge for each hole had been computed. The foremen were furnished with small printed sheets, prepared by the surveyor, giving the number of the holes to be loaded by each squad and the number of cartridges required in each hole. Each squad carried its own cartridges, one boxful at a time, from the foot of the shaft to the heading to which it was assigned; the cartridges were shoved home with a wooden rod, and, as each cartridge went in, a corresponding tin tag, taken from the powder-box, was strung on a wire with the tin tag bearing the number of the drill-hole. The bunches of tags thus formed were collected by the foremen, and turned in to the surveyor, who thus verified the charge put in each hole, and kept an accurate account of the distribution of all the explosive in the mine.

In all cases the last cartridge put in each hole was dynamite, the range of sympathetic explosion for this material having been accurately determined by a series of experiments reported in the Annual Report of the Chief of Engineers for 1885. The end of the cartridge was allowed to project from the drill-hole a distance of about 6 inches, that it might receive the full effect of the blow from the primary charge intended to fire it. It was solidly wedged in this position with pine wedges.

Where the galleries were low, the drill-holes in the roof could be reached from the floor, but, as the top of the galleries followed in a general way the surface of the rock, their height varied from 5 feet to 33 feet, and special provision had to be made for reaching the high holes. This was accomplished by the use of sectional scaffolds, mounted on the mine cars and rolled along on a portable track; their height could be altered in a few minutes to any elevation wanted.

With the exception of a little inconvenience caused on several occasions by the non-arrival of the supply of dynamite when due, the work of loading the drill-holes progressed with the utmost smoothness and regularity from July 30 to its completion, September 28.

But one unforeseen difficulty occurred during the whole work. Notwithstanding the test that the copper cartridges had been subjected to, it was discovered towards the end that some of them were corroded. On nvestigation it was found that some of the water that leaked into the mine through the drill-holes was strongly charged with sulphur, which rapidly attacked the copper cartridges. From the locations in which this effect was found to be the most pronounced it is believed that the sulphur came from the ashes used for filling in behind the sea-wall in constructing the small island on which the plant was located, and possibly also from the wrecks of coal barges, many of which have been lost on the reef.

The trouble was discovered before any great damage was done, and a remedy was readily found by coating the cartridge with a wax made of resin, beeswax, and tallow, put on hot; but, although only 536 cartridges were seriously damaged, the question of the integrity of the cartridge was of such vital importance that it was deemed prudent to take out in all 7,759, both rackarock and dynamite.

The labor of withdrawing such a number of charges from the drill-holes, dipping them in melted wax, and replacing them, besides being an exceedingly delicate operation, made an amount of extra work, at a time when all hands were fully occupied, that added immensely to the difficulty of the final preparations.

When the loading was completed, the charge consisted of 240,399 pounds of rackarock and 42,331 pounds of dynamite, distributed over the whole nine acres of the reef in proportion to the volume of rock plus one-fourth the volume of water overhead.

Where the rock was very hard it was allowed 25 per cent. extra, and where exceptionally soft a reduction of 25 per cent. was made. The number of cubic yards of rock to be broken by the blast was 270,716.7, so that the charge was at the rate of 1.04 pounds per cubic yard.

The charge at the final blast at Hallet's Point in 1876 was 0.79 pounds per cubic yard; but an increase was deemed necessary at Flood Rock, because the thickness of the roof was much greater, and because the amount of rock excavated from the galleries was 2.7 times less in proportion to the amount of rock to be broken by the blast than at Hallet's Point, and consequently the whole of the reef had to be lifted to allow it to break, instead of getting the breaking effect of a fall, as at Hallet's Point.

When work of this kind was first undertaken at Hell Gate it was believed to be possible to make an excavation below the reef capable of receiving all the débris from the roof and pillars, and so gain at once the required depth of water. But on account of the seamy and treacherous nature of the rock of which the Hell Gate reefs are composed it is found that when the excavation becomes very large an inordinate amount of expensive timbering has to be done, as the falling of a single large block of stone from the roof (a very common occurrence in ordinary mining and tunneling) might result in flooding the whole mine in a few minutes. Besides, as broken stone takes up much more space than the same amount of rock before it is broken (at Hallet's Point the ratio was 1.45), to make certain of having the required depth immediately after the blast it would be necessary to excavate at least twice as much rock from the mine as it was intended to break up by the final blast. The average thickness of the roof at Flood Rock was 18.86 feet.

As this kind of excavation is necessarily costly, the ultimate cost of the result produced would be exceedingly high. It was, therefore, early decided in the course of the work at Hallet's Point to excavate only a relatively small amount (0.78 yard per yard of roof), but to thoroughly break up the roof by the final blast and remove so much of the débris as might be necessary by dredging.

The expectations of the engineer were so well fulfilled in this case, and such good results were obtained with the dredging, that it was decided to make a still further saving of expense at Flood Rock by an extension of the same policy, and during the later years of the work the excavation was limited as much as possible, only such galleries being run as were necessary to admit of the drill-holes for the explosives being properly distributed.

The excavation at Flood Rock, therefore, amounted to 0.296 cubic yard only per cubic yard broken by the final blast, and instead of any greater depth on the reef being looked for after the blast, it had been computed that there should be a shoaling averaging several feet over the whole reef.

In all the work done in Hell Gate the near proximity of tall buildings in New York City and on Ward's and Blackwell's islands had to be constantly borne in mind. It had already been well settled by the experience acquired at Hallet's Point, that a large factor controlling the shock transmitted through the ground is the size of the individual charges, and that no fear need be felt in firing even as large a blast as 288,936 pounds at Flood Rock, provided it be sufficiently distributed. It was, therefore, tried as far as possible to limit the charges to 25 pounds per drill-hole, though in a few cases charges as great as 37 pounds could not be avoided. The average charge was 22.5 pounds.

The drilling of holes of sufficient size to hold such charges, slanting upwards into the roof, was a work of exceptional difficulty that had to be met with the invention of special appliances; 13,023 such holes were drilled, aggregating 113,102.15 feet in length. Only 12,561 of these holes were actually charged, a considerable number having to be rejected on account of the pressure of the water flowing in them being so great as to prevent their being used.

The arrangements for firing simultaneously this large number of charges were reduced to great simplicity. Elaborate experiments (reported last year) were made early in the season to determine with certainty to what extent sympathetic explosion could be relied on in firing the mine, and it was decided to dispense with connecting wires to the drill-holes entirely, it having been ascertained that the explosion of a charge of 10 pounds of dynamite under water will fire with certainty any number of other charges of dynamite packed solidly in thin elastic envelopes within a radius of 27 feet. Primary charges of 10 pounds of dynamite were therefore placed at intervals of 25 feet along the galleries from which the holes were drilled, and these primary charges only were connected with the batteries. There were 591 of them, arranged on 24 different circuits.

They consisted of two 2¼ inch by 24 inch thin copper cartridges solidly packed with dynamite, lashed on horizontal timbers from 3 to 12 feet above the floor, according to the height of the gallery; each cartridge also containing a 30-grain fulminate cap. On the top of the two cartridges a small primer was lashed, made of stiff brass, containing the platinum fuse fastened to the wires connected with the battery and half a pound of dynamite put in loose.

In locating the primary charges care was taken to have alternate charges on different circuits, so that in the event of a failure of any circuit its charges would nevertheless explode by sympathy, being within less than 27 feet of four other primaries on three other circuits, and part of the dynamite being solidly packed in thin elastic envelopes. The dynamite in the brass primers was put in loose, because in this shape it is but little affected by water, and it was difficult to make cer-

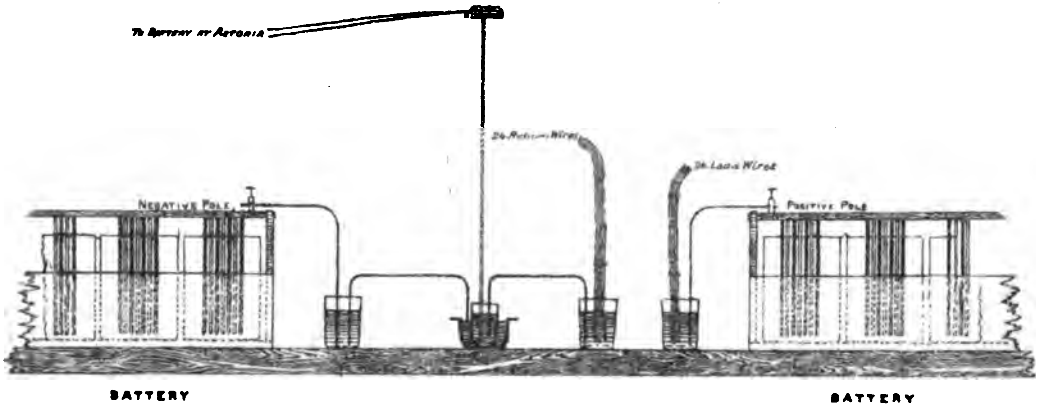


FIG. 5

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tain of the tightness of the packing of the wires in the neck of the primer.

The circuits were made without joints, the wires being cut to the proper length and the platinum bridge soldered directly to them, and the gutta-percha insulation of the wire was carried over the whole fuze. Twenty-one of these circuits contained 25 fuzes, each connected with wires 52 feet long, of No. 18 copper insulated to No. 9, with lead wires at each end of the circuit, 600 feet long, of No. 12 copper, insulated to No. 9 A wire gauge. The remaining three circuits contained 22 fuzes, each connected with wires 106 feet long, and having lead wires of 950 feet; these circuits, intended for the extreme northern portion of the work, were nearly a mile in length. The bridges of the fuzes were of pure platinum wire 0.0005 of an inch thick. They had a resistance of 1.73 ohms cold and 2.76 ohms when heated to the exploding point. It required a current of 0.615 amperes to explode them when connected in series.

The number of fuzes and the amount of wire in each circuit were so adjusted that at the instant of explosion all should have the same re-resistance, 77.43 ohms.

These values were determined in advance by the engineers of the work.

The circuits were made to order by the Laflin & Rand Powder Company, under the personal supervision of Mr. H. Julius Smith, who also made the fuzes for the Hallet's Point blast. Mr. Smith kindly volunteered to assist in laying the wires in the mine, and rendered valuable assistance in this delicate and tedious work. The wires were laid in about 26 hours, under the personal direction of Lieutenant Derby, by four gangs made up of the most intelligent of the miners.

The battery used in firing the mine was furnished by E. S. Greeley & Co., and consisted of 60 bichromate cells coupled in series. The plates were 6 inches by 9 inches, four carbon and three zinc in each cell, separated by only one-fourth of an inch. The electromotive force of the cells was between 1.95 and 2.07 volts; the internal resistance was less than 0.01 ohms. The battery was of sufficient power to send through every fuze a current just double that computed to be necessary to fire it.

On account of the grave objection to having any joints in the wires under water, and the great advantage of having no resistance between the battery and the point of separation of the different circuits, the lead wires from each circuit led directly to the battery, which was located at the head of the shaft on top of the rock.

The arrangement of the circuit closer is shown in Fig. 5. Two large mercury cups formed the poles of the battery. One of these cups received the ends of the twenty-four lead wires, and the other was connected by a heavy band of copper with the mercury in a stout iron cup, in which sat a thin glass tumbler, also containing mercury. A stout copper strip connected the mercury in this glass with that in another mercury cup which received the twenty-four return wires.

The circuit was closed by breaking the thin glass, and allowing the mercury in it to mix with that in the iron cup. A long quarter-inch iron rod, terminating at its upper end in a small disc, was passed through a hole in the roof of the battery house, and stood up in the thin glass tumbler with its point resting on the bottom of it. A thirty-grain fulminate fuze was laid on the disc, and fastened to it with wax a few inches above the roof of the battery house, and was fired by means of a small battery at Astoria. The blow struck by the fuze on the disc and transmitted by the iron rod had been found by experiment to be so sharp as to reduce the glass tumbler to dust without splashing the mercury.

The mine was fired from a point on the Astoria shore, about 1,000 feet away, at $11^h\ 13^m\ 50^s$ standard time, October 10, 1885.

Three instantaneous photographs were taken under the direction of Lieut. Col. H. L. Abbot, Corps of Engineers, at different periods of the upheaval. The first of these, taken two-tenths of a second after the closing of the circuit, shows the water rising nearly uniformly over the whole site of the reef, and illustrates well both the completeness of the explosion and the simultaneity of the action of the separate charges. As was expected, there was no loud report, no severe shock through the earth, and no scattering of the débris.

Lieutenant-Colonel Abbot's report on the transmission of the vibration through the earth is submitted herewith.

Examinations of the reef were commenced the next day, and it was inspected on six successive tides by an experienced diver. He reported the bottom broken in large blocks, separated by cracks, but not turned over with ragged edges on top. In many cases the cracks were large enough for him to crawl into.

A survey of the whole reef was commenced at once and has since been completed. It shows that the surface of the whole reef has been altered, proving the reef to be shattered, and the changes are nowhere greater than at the most remote corner of the reef, where the bottom has been raised 10 feet.

Thanks to the use of rackarock instead of dynamite, and the utilization of sympathetic explosion instead of wires and fuzes for firing the mine, and the savings effected in many details, a balance of about $100,000 from the appropriation of July 5, 1884, for firing the mine remained available to commence the dredging.

It was decided to apply this sum in such a way as to produce the greatest immediate benefit to navigation, which was in reducing the dangerous reefs known as the Negro Heads and Hen and Chickens to a depth of 18 feet at mean low water, a depth sufficient for at least 90 per cent. of the vessels passing through Hell Gate, and giving an effective width of 350 feet to the Middle Channel, previously too narrow and tortuous to be used by any but the smallest vessels.

Bids were at once called for on advertised specifications, and a contract entered into with the Atlantic Dredging Company, of Brooklyn, for the removal of about 30,000 tons of rock, at $3.19 per ton, the contractor to do his own surface blasting. This price was considered satisfactory, the first part of the work being the most difficult, on account of the blocks of stone on the surface being the largest, as they are the furthest away from the drill-holes containing the explosives.

The third contract on Hallet's Point, let on the same terms as to surface blasting as the Flood Rock contract, was made at $3.39 per ton.

It will be seen from the report of Lieut. Col. Walter McFarland, Appendix E 5, that at the close of the fiscal year the contract had been nearly completed, 28,622.312 tons of rock having been removed.

The reef had been attacked in four different places, and so far from any exceptional difficulty with the dredging having been encountered, the progress made is unprecedented, the largest of the dredges having averaged up to May 1 80.5 tons per working day, while on Hallet's Point the same machine only averaged 50.4 tons for a like period. The cost of the surface blasting done by the contractor up to June 30, 1886, amounted to only 13.4 cents per ton of rock removed.

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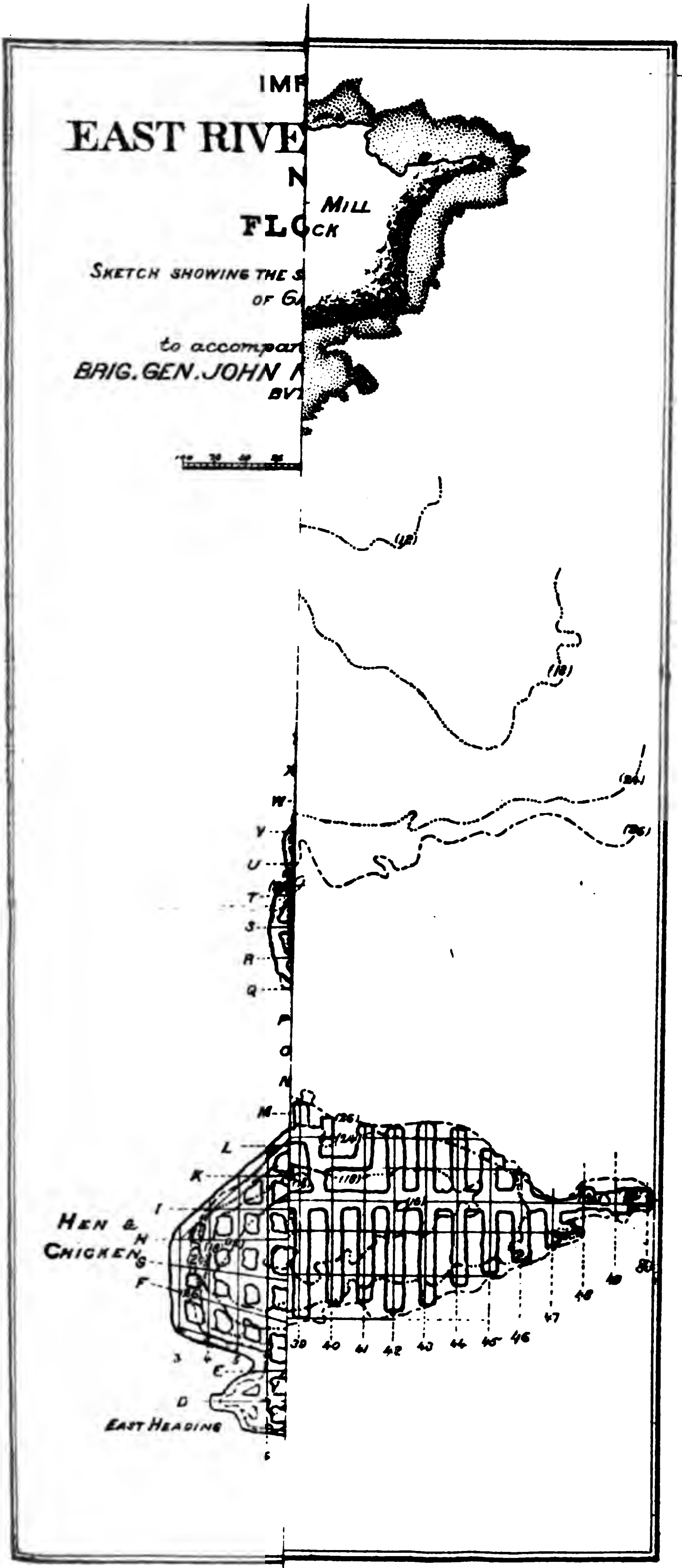

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It is estimated that the total amount of broken rock to be removed to give a clear depth of 26 feet at mean low water over the whole reef is 294,000 tons, which should be removed in about three years if no delay is caused by lack of appropriations.

As any sort of an accident in the handling of the large quantity of explosive used at Flood Rock would probably have resulted in the loss of the whole work, it is evident that the success achieved is attributable to the faithfulness and intelligence of every employé on the roll, every one of whom had important and responsible duties to perform.

The services of Nicholas Terry, overseer; Edward Matthews, Peter Boyle, and John Wills, foremen; and James Quigley, recorder, are specially worthy of mention.

Mr. J. M. Gore and W. L. Quinn, overseers of the drill-scow, rendered valuable services as inspectors; and Mr. G. W. Kuehnle, surveyor, in addition to his regular work, performed a variety of duties most creditably.

As Chief of Engineers my duties confined me for the most part to my station in Washington; and Col. Walter McFarland, who obligingly consented to assist me in the closing operations at the reef, was compelled, in deference to the proper care of the numerous works in his charge, to be frequently absent, the result being that the actual oversight of the preparations for the explosion fell upon Lieut. G. McC. Derby, of the Corps of Engineers; and I know no one who could have performed the difficult task with more skill and conscientious care.

Respectfully submitted.

JOHN NEWTON,
Brig. Gen.,
Chief of Engineers.

The CHIEF OF ENGINEERS.

Tabulated statement of the amount and cost of work done at Flood Rock, Hell Gate, East River, New York, from June 7, 1875, to October 10, 1885.

Nature of work.	Number of shifts of 8 hours worked.	Cost of plant.		Cost of repairs to plant.		Operating expenses.		Total expenses.	Cost of mining 80,231.94 cubic yards of rock in galleries 10 by 10 feet.		Cost of drilling for final blast.	Cost of final blast.	Cost of maintenance while idle.	Total cost.
		Materials.	Wages.	Materials.	Wages.	Materials.	Wages.		Total.	Per cubic yard.				
Sea-wall and foundation	25,521.875	$2,918 26	$14,458 65					$17,376 91	$15,750 74	$0.196	$1,617 16			
Drilling	107,502	24,970 04	4,819 39	$19,672 55	$26,841 37	$42,902 44	$248,974 70	368,180 49	308,240 26	3.841	59,940 23			
Blasting	4,634.125				117 28	86,989 35	11,588 08	98,694 71	98,694 71	1.23				
Hauling	52,052.125	2,036 78	4,507 85	1,961 52	4,936 75	10,772 00	97,128 46	121,433 36	121,433 36	1.513				
Hoisting	3,892.75	7,535 21	4,477 20	1,433 41	1,816 33	9,219 46	8,059 14	32,540 75	32,540 75	0.405				
Dumping	5,867.875	2,997 85	604 32	1,022 62	1,680 33	4,681 01	6,788 47	17,774 60	17,774 60	0.221				
Pumping	8,488.625	10,020 68	3,459 73	4,004 42	7,740 43	27,882 44	16,508 56	69,616 26	59,557 50	0.742	6,115 24	$3,943 52		
Ventilating	1,389.75	1,374 30	853 44	454 70	663 16	5,848 17	2,218 79	11,412 56	10,349 04	0.129	1,063 52			
Timbering	3,569.625					2,183 99	7,582 19	9,766 18	8,843 42	0.11	922 76			
Transportation	7,988.625	15,383 92		6,153 86	5,787 02	5,694 44	20,151 68	53,170 92	51,309 76	0.639	1,861 16			
Surveying	8,259.875			129 45	42 12	472 26	27,283 15	27,926 98	24,016 98	0.30	3,910 00			
Maintenance of plant while idle	10,818.125			2,755 36	11,819 72	9,266 66	19,082 08	42,923 82					$42,923 82	
Final blast	5,816.125					91,185 83	16,118 65	107,304 48				107,304 48		
Office expenses and superintendence	19,210.625		1,242 47	16 50	7,150 65	14,545 65	60,905 89	83,861 16	76,056 80	0.948	7,804 36			
Total	265,012.125	67,237 04	34,513 05	37,604 39	68,595 16	311,643 70	542,389 84	1,061,983 18	824,576 92	10.277	83,234 44	111,248 00	42,923 82	$1,061,983 18

Cost of drilling per linear foot: 2-inch hole, $0.316; 3-inch hole, $0.53.

Number of feet of galleries driven	21,668.88
Number of cubic yards of rock mined	80,231.94
Number of 2-inch holes drilled	235,318
Number of 2-inch holes fired	223,545
Number of feet of 2-inch holes drilled	974,446.42
Number of feet drilled per cubic yard mined	12.14
Number of feet drilled per machine per shift	29.8
Number of pounds of explosives used in mining (principally dynamite No. 2)	184,407,125
Number of pounds of explosives used per cubic yard mined	2.29
Number of 3-inch holes drilled for the final blast	13,023
Number of feet of 3-inch holes drilled	113,102.15
Number of feet of 3-inch holes drilled per machine per shift of eight hours	20.32
Number of cubic yards broken by final blast	270,716.7

THE EARTH WAVE AT THE DESTRUCTION OF FLOOD ROCK.

BY LIEUTENANT-COLONEL HENRY L. ABBOT,

Corps of Engineers, Brevet Brigadier-General, U. S. Army.

CONTENTS.

Letter of transmittal.
Report of General Abbot.
A. The explosion at Hallets Point in 1876, by General Abbot.
B. Velocity of transmission of earth waves, by General Abbot.
C. Seismographic observations at Astoria in 1885, by Captain Knight.
D. Determination of the instant of explosion in 1885, by Captain Bailey.
E. Photographs taken at Astoria in 1885, by First Lieutenant Lusk.

ILLUSTRATIONS.

Plate I. Electrical connections.
Plate II. Seismographs at Astoria.
Plate III. Map of vicinity of Flood Rock.

LETTER OF TRANSMITTAL.

WILLETS POINT, N. Y., *December* 29, 1885.

GENERAL: I have the honor to transmit herewith my report upon the observations, undertaken by your direction, to determine the rate of transmission of the earth wave caused by the recent Flood Rock explosion. * * *

Very respectfully, your obedient servant,

HENRY L. ABBOT,
Lieut. Col. of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers.

REPORT OF LIEUTENANT-COLONEL HENRY L. ABBOT, CORPS OF ENGINEERS.

WILLETS POINT, NEW YORK HARBOR, *December* 15, 1885.

Brig. Gen. JOHN NEWTON,
Chief of Engineers:

GENERAL: I have the honor to submit the following as my report upon the observations undertaken by your direction to determine the rate of transmission of the earth tremor caused by the recent explosion at Flood Rock, and upon the arrangements for securing photographs of the upheaval. In this connection I would respectfully refer to the appended papers marked A and B, giving the results of similar observations made at the destruction of the Hallets Point reef in 1876, and at various torpedo explosions, which will obviate the necessity of many details in this report.

PRELIMINARY PREPARATIONS.

The most delicate and trustworthy form of seismoscope available was the mercury arrangement employed in 1876. Four of that pattern were prepared by Captain Knight from condemned surveying instruments in depot at Willets Point. The magnifying power of the observing telescopes was about 18 diameters. The object to be observed was the reflection of the cross-hairs of a similar telescope (of which the eyepiece was removed to assist in focussing). These telescopes were secured to a wooden frame, with an artificial horizon of mercury resting between them upon solid earth. At Willets Point use was also made of a Thomson reflecting galvanometer mounted upon a solid pier in the electrical observatory.

As the observation of 1876 had sufficiently shown that the rate of transmission of the earth wave is much too rapid for satisfactory measurements in the near vicinity of the explosion, none were attempted directly at Astoria; but an approximate result was secured by an electrical device described below, and Captain Knight obtained some interesting data upon the intensity and direction of the shock, for which reference should be made to his report, appended and marked C.

To secure the highest precision in such observations, the explosion must print its own time record upon local chronographs in an electric circuit connecting the observing stations; and each observer must print the instant of arrival of the tremor upon his own chronograph sheet by an electrical key. Through the kindness of the officers of the Western Union Telegraph Company and of the Long Island Railroad, who placed their lines and offices at my disposal for the purpose without charge to the Government, this method was employed at all my stations except Willets Point.

To render observations at that station of value, and to extend the use of the same method to volunteer observers throughout the entire district affected by the shock, who might be able to determine with precision the error of their chronometers, special care was taken to determine the absolute time of the explosion. Captain Bailey was charged with this duty, and his report, appended and marked D, shows that the work was successfully accomplished with a probable error not exceeding half a second. To assist the observers of the Geological Survey and their co-operators in eliminating errors in time determinations, that office was informed that the beats of the break-circuit chronometer, which had recorded automatically the instant of firing the mine, would be sent to the Western Union Telegraph office in New York City immediately after the explosion, for transmission to such places as might be arranged for with the officers of the company. No advantage was taken of this offer.

In respect to photographic views of the explosion, it was well understood that many would be taken by ameteur and professional observers, and the limited facilities of the School of Application at Willet's Point (only three cameras suitable for this purpose) were therefore devoted to the first instants of the explosion, which not only possessed the highest scientific interest, but which also would afford conclusive evidence as to the general or partial nature of the explosion. These three cameras were accordingly arranged to be operated electrically, the slides being released by the explosion of fuzes at times recorded on the chronograph. The first picture was taken automatically, by the same key and motion which exploded the mine; the others were taken at will by Lieutenant Lusk, in charge of the photographic party, whose report is appended and marked E. A fourth camera was kindly loaned to Sergeant von Sothen, Company C, Battalion of Engineers, by Mr. J. F. Wieners, jr., of College Point, and was operated by him in the usual manner, under instructions to secure a view at the instant of maximum display.

OBSERVING STATIONS.

The outlying stations occupied by officers of the Battalion of Engineers on Long Island were Willets Point, Pearsalls, Bay Shore, and Patchogue, the latter three connected by telegraph with the firing station at Astoria. At West Point, First Lieut. Wallace Mott, Eighth Infantry, in charge under Professor Michie, of the astronomical observatory, assisted by First Lieutenant Beach, Corps of Engineers, and First Lieutenant Stuart, Ordnance Department, co-operated.

The precise Long Island stations were selected after a personal inspection by Captain Knight, to secure so far as possible exemption from deceptive earth tremors. The general distances were chosen according to my best judgment, guided by the researches made in 1876, and reported in Appendix A. The formula resulting therefrom (for a magnifying power of 12 diameters) is the following, in which D denotes the distance in miles separating the initial disturbance from the instrument, and C the weight of dynamite No. 1 in pounds:

$$D=\left(\frac{C^{\frac{1}{2}}}{1.63}\right)^{\frac{5}{6}}$$

The charge at Flood Rock being 240,399 pounds of rackarock and 48,537 pounds of dynamite No. 1, equivalent to about 310,000 pounds of the latter, this formula indicates that the tremor should be detected with a magnifying power of 12 diameters at a limiting distance of at least 129 miles.

ELECTRICAL SYSTEM ADOPTED.

The electrical connections will be understood from the accompanying plate.

The main line extended from earth at West Point to earth at Patchogue on Long Island, the battery (dynamo machines) being intermediate at the New York office of the Western Union Telegraph Company.

At each observing station (except Astoria) the current flowed continuously through the coils of a 150-ohm relay, thus keeping all the local circuits open. A break in the main circuit closed these local circuits, each consisting of 5 small Grove cells working through a Morse register, and thus made a mark on the moving fillets. Each observer at the seismoscope in the vicinity held a close-circuit key in his hand and thus could make a mark on his own fillet at pleasure. The officer acting as electrician remained at the telegraph station and regulated the apparatus, according to a prearranged programme.

At Astoria the circuits were as follows: The main line passed through the contact points of a 50-ohm relay held together by a local battery of two Grove cells—which traversed its coils, those of a second 50-ohm relay controlling an open circuit, a break-circuit chronometer No. 1499, by Negus, a break-circuit key and a set of closed contact points on the firing key. The breaks of the chronometer were thus printed at all of the observing stations; and also on a local chronograph connected with the contact points of the second 50-ohm relay, a local battery of three cells furnishing the needful current. By this arrangement not only were the seconds of the chronometer printed at all the observing stations, but warning signals could be sent at will from Astoria by using the break-circuit key; and the explosion was recorded throughout the line by the first movement of the firing key.

This firing key controlled two other circuits—one to explode the mine, and the other to take a photograph of the rock instantly thereafter.

The firing circuit extended from earth at the Astoria station through 20 Grove cells, the firing key, a submarine cable to the fuze at Flood Rock (arranged to break a glass of mercury and thus close to the great battery circuit), and thence to earth. The only break being at the firing key, a motion of one-eighth of an inch effected the explosion.

The photograph circuit was closed by the same motion of the firing key, but at a later instant, by a simple mechanical arrangement. Lest this arrangement should not give enough retardation to secure a picture after the effects of the explosion became visible, a relay was introduced to take advantage of its armature time. When its contact points came together, the circuit of 10 Grove cells was closed through a fuze holding the camera slide, and also through the chronograph. This chronograph being a Morse register with an indenting point, the increase of battery power from three cells to ten cells made a deeper mark, which was easily distinguished from that caused by the first motion of the firing key. Lieutenant Lusk held a special key operating the other cameras and took the subsequent pictures at will, recording their times by the 10-cell battery on the chronograph, as will readily be understood from the plate.

THE EXPLOSION.

The parties at the outlying stations, each consisting of two officers and six enlisted men of the Battalion, proceeded by rail to their posts on October 9. In accordance with your instructions issued upon the application of the civil authorities at Astoria, Captain Price, with his Company C of the Battalion of Engineers, aggregating 125 men, embarked with myself and the observers and assistants for duty at Astoria on the same evening on the steamboat Castleton, and we spent the night on board. Early on the morning of October 10, the work of laying the connecting wires (nearly a mile and a half long) and of setting up the batteries and electrical apparatus was begun, and by the efficient assistance of First Lieutenant Roessler, Sergeant Brown, Lance-Sergeant Warner, and the detail of privates, was completed about 10 a. m. Captain Knight had by this time arranged his own apparatus. First Lieutenant Lusk assisted by Sergeant von Sothen, had established the four cameras in the best positions. Everything with us was ready for the explosion.

Certain volunteer observers who failed in securing results have criticised in an unfriendly spirit the delay of less than fourteen minutes which occurred in firing the mine. If they had comprehended how this unavoidable delay on the rock endangered the success of the official measurements intrusted to me, they would doubtless have taken a more charitable view of the matter. Everything with us was staked on over one hundred miles of busy telegraph wires remaining free from interruption. Any impatient operator on the line who might imagine that the explosion was over, had it in his power unwittingly, by breaking in upon us, to destroy not one but all our observations on the main line from Patchogue to West Point. I had begun to despair of success everywhere except at Willets Point. For that place I felt secure; because the precaution had been taken to station two officers at each instrument, with instructions to relieve each other, if necessary, and continue observing until the tremor came, or until a telegram was received at Whitestone (2¼ miles distant) announcing the deferring of the explosion. A mounted soldier had been stationed there in readiness to convey the message, so manifest was the possibility of a long delay in so complicated a series of operations as the firing of this mine. It is to be regretted that similar precautions were not taken elsewhere. Work of this nature cannot in practice be regulated with the precision of the transit of a fixed star.

At length the last party left the rock; and immediately thereafter, at 11h. 13m. 50.2s. mean solar time of the 75th meridian, the mine was fired by little Miss Mary Newton, who pressed the key with the quick and self-possessed motion necessary to ensure the success of all our electrical arrangements; no one could have done it better, and never before was unstable equilibrium between natural forces illustrated upon so grand a scale through human agency.

RESULTS OF THE MEASUREMENTS.

The following is a summary of the reports of the several parties acting under my direction, with such other data as have been furnished by friends or made public, respecting the rate of transmission of the earth wave. They are arranged in the order of increasing distance from the explosion upon two lines—one extending eastward across the drift formation of Long Island, and the other northward through the solid rock underlying that region.

Experience at the Hallet's Point explosion had shown the necessity of having two officers at each outlying station, one to attend to the electrical arrangements and communicate with Astoria, and the other to use the seismoscope at the best place in the vicinity to which electrical connections could readily be extended. As the highest interest attached to the more distant stations, the officers senior in rank were assigned to them. All did their work admirably and were completely successful.

The distances from Flood Rock to all the stations at which observations are discussed in this report (except that to Willets Point, taken directly from the Coast Survey chart), were kindly furnished by that office, the exact positions of the Long Island railroad stations with respect to the general topography being identified from Colton's large map of Long Island. These distances may therefore be accepted as known with exceptional precision.

Willets Point.—Distance, 8.33 miles; officers at astronomical observatory, Lieutenant Chittenden and Lieutenant Taylor; officers at the torpedo laboratory, Lieutenant Gillette and Lieutenant Sibert; distance between these stations, about a quarter of a mile. They were connected by telegraph wires, so that the standard chronometer printed seconds on both chronographs.

The observations at the astronomical observatory were made with the same form of mercury seismoscope that was used elsewhere; those at the torpedo laboratory were made with a delicate Thomson's reflecting galvanometer placed on a solid pier disconnected from the building, the needle being rendered specially sensitive to tremors by being thrown slightly out of level. I hoped to obtain an approximate measure of the duration of the earth tremor from this instrument, by noting (1) the angular swing and the duration of the disturbance caused by the explosion; and (2) the duration of an equal angular swing caused artificially immediately thereafter. The difference between these times should measure approximately the duration of the earth tremor. The following extracts from the reports of the officers give all needful details:

Lieutenant Chittenden (in charge at astronomical observatory) reports:

"At the astronomical observatory arrangements were made to note the arrival of the shock upon the chronograph used there in astronomical observations.

"As the explosion was expected to take place at 11 a. m., I started the chronograph at 10.45 a. m. to allow for any difference of watch times. This was about 12 hours and 8 minutes sidereal time.

"For the purpose of marking a particular minute on the chronograph and on the register at the laboratory, I threw the chronometer out of the circuit for five seconds at five seconds past the 13th minute, again at thirty seconds past the same minute, and again at five seconds past the 17th minute. After the tremor from the explosion had passed, I noted the last minute recorded on the chronograph before it was stopped. Its number was thirty-seven. These times were carefully noted, and I thus had three independent means of determining the minute in which the record of the arrival of the tremor was made.

"The rest of the time I watched the chronograph steadily, to see that it continued to work all right. I was looking at the pen point at the time of the arrival of the tremor. All I noticed was a slight shock to the building, and simultaneously with it a distinct rumbling sound, audible, I should say, for three seconds. At almost the same instant that I felt the shock I noticed that Lieutenant Taylor had recorded its arrival on the chronograph. Lieutenant Taylor made four separate records on the chronograph, which he numbered one, two, three, and four, and which are explained in his report. I numbered them on the chronograph as he called them out to me. The uncorrected times, as taken from the chronograph record, were:

No.	Sidereal time.		
	h.	*m.*	*s.*
1.........	12	35	32.3
2.........	12	35	44.0
3.........	12	35	51.4
4.........	12	36	52.8

"The Lukens time of the explosion, as given me by Captain Bailey, was 12h. 35m. 23.8s. The time from the explosion until the arrival of the tremor at Willets Point was, therefore, 8.5 seconds."

Lieutenant Taylor (at astronomical observatory) reports:

"The basin of mercury was placed on the zenith telescope pier in the east end of the observatory, and this gave a very firm base, and one which from its good connection with the ground would show a very slight tremor.

"The first mark made by me on the chronograph records the time that I observed the first arrival of the tremor. The second was when the wires became visible again. The third was when I thought there was a slight increase in amplitude of the vibration. Of this I am not at all certain, as even at this time the wires were vibrating so rapidly that it was very difficult to tell whether there was a slight increase or not. The fourth mark was made when the wires were perfectly still. The shock appeared to reach its maximum intensity instantly; but of this I am not positive, for as soon as the shock caused the mercury to move at all the wires instantly disappeared from view, and the tremor may have increased in violence after it arrived and before the wires again became visible. It certainly did not arrive gradually.

"I do not think that the wires vibrated off the field of view, but they vibrated so rapidly that they could not be seen except as a sort of a blur over the field. It was about twelve seconds before they became quiet enough to be distinguishable at all.

"From this time until they were perfectly still they appeared to settle quite gradually, but with less and less rapidity as they came nearer to rest, except at the time marked by my third break. I think it more than probable that I was mistaken about there being an increase, for the reason given above. If there was any increase it was very slight.

"The wires vibrated the whole time as if there were a succession of shocks rapidly following each other. It appeared as if the mercury basin was tipped rapidly backwards and forwards, this appearance being much more perceptible about the time the wires first became visible than it was just before the mercury became still.

"The wires finally became perfectly still in about one minute and twenty seconds after the first shock. As my instrument was perfectly protected from any wind, and great care had been taken to prevent any one being near the observatory to cause any disturbance, I believe that this is very near the exact time that there was any movement in the mercury.

"The sound, which was distinctly heard, was sort of a low, rumbling noise, and it seemed to arrive at the same instant as the first shock."

Lieutenant Sibert (at the torpedo laboratory) reports:

"The instrument used was an ordinary Thomson reflecting galvanometer set very delicately so that the slightest jar would cause the mirror to swing. The instrument was mounted on a pier resting on the firm earth and entirely disconnected from the building. Epochs were recorded by breaking the circuit of a Morse register, connected through a relay with the Lukens chronometer circuit at the astronomical observatory. The objects of the observations were to determine the duration of the shock, and roughly the rate of transmission. The first of these was accomplished by noting the time from the first motion of the mirror until it came to rest; this first swing was the maximum observed. Hence by giving the mirror the same swing and noting the time that it took to come to rest, and taking the difference between this time and the time it took the mirror to come to rest from the shock, we arrive at the duration.

"The adjustment of the instrument for delicate work of this nature was found to be different from that for electric current observations; for if the mirror hung perfectly free, the only way for the earth tremor to be transmitted to it would be through the whole length of the suspending fiber. Practical experiment showed that a point of contact of the fiber other than the point of support was necessary for delicate work. The instrument was not adjusted as delicately as possible, for fear the light would be thrown off the scale and the maximum reading not obtained. To render this less likely to occur, two scales were used placed end to end so that the light fell at their junction.

"I marked five epochs on the register, lettered A, B, C, F, and G; the following is a copy of the notes written immediately after the observation was over.

"Light stood at 363 on right-hand scale.

"(A) Time of first motion of mirror, the light swung back to about the 210 division, making about 153 divisions.

"(B) It seemed to remain swinging to the 250 division (giving 113 divisions) for a second or so, then gradually lessened to its arc at epoch C.

"(C) The mirror from this epoch seemed to continue swinging to the same small angle to epoch F.

"(F) From F the mirror gradually stopped swinging.

"(G) The motion ceased at G.

"I heard a rumbling sound about a second before I saw any motion of the mirror. which makes me believe that the instrument was not delicate enough to catch the first tremors caused by the explosion, which of course would make the result as to velocity of transmission and duration of shock too small. Assuming that the instrument recorded the first tremor, the way in which each successive wave affected the mirror that is whether it increased or decreased its amplitude of swing, would in my opinion render the result as to duration uncertain. In experiments made afterwards to determine the time it took the mirror to come to rest from a swing of 153 divisions, I noticed that when the amplitude of swing began to be quite small, the mirror settled much faster than it did in the case of the explosion, which showed that there was a slight vibration of the earth for some time after the main shock passed. These small vibrations would probably have had little effect upon the mirror settling from a swing of considerable amplitude. If these slight tremors continued long enough to be the only cause of the motion of the needle just before it came to rest, thus eliminating the effect that any previous interferences might have had upon the amplitude of swing, then the question of duration would be approximately solved."

Lieutenant Gillette (in charge at the torpedo laboratory) reports:

"The local circuit was run by five Grove cells, the key being as far removed from the galvanometer as possible, and the wires twisted together so as to effect the chronometer the least.

"The fractions of seconds on the record were measured with a glass scale reading to tenths (hundredths were estimated). The even minute was received by dial telegraph from the observatory.

"The five epochs were:

Epochs.	Time.		
	H.	*M.*	*S.*
A	12	35	32.65
B	12	35	45.20
C	12	36	13.00
F	12	36	43.15
G	12	37	03.95

"The Lukens time of explosion as given by Captain Bailey was 12h. 35m. 13.78s.

"This gives a time of transmission of 8.87 sidereal seconds, or 8.85 mean solar seconds.

"Six observations were made immediately after the explosion to determine the normal time for the mirror to come to rest after a swing equal to that due to the shock. The required swing was given by a pocket knife held for a moment near the instrument, epochs being recorded and measured as before. The mean of these observations after applying Pierce's criterion was 28.74 seconds. The duration of swing caused by the shock (A to G) being 91.30 seconds, we have for the duration of the tremor 62.56 mean solar seconds.

"While watching the register I distinctly realized that the shock had passed (whether I heard it or felt it I am unable to say) at least a second before any record was made on the register by the observer. I am inclined to think that it was the sound transmitted by the earth, and that the sound vibrations were different from and preceded what is known as the earth tremor. The phenomenon could scarcely be accounted for by lack of delicacy in the instrument, which, though not adjusted to its highest attainable delicacy, was really extremely sensitive to anything of the nature of a shaking of the ground. It was adjusted so as to be swung 15 divisions by a man jumping on the ground in the vicinity of the building. As the explosion swung it over 150 divisions, it certainly should have been moved by a very trifling earth tremor."

Pearsalls, Long Island.—Distance 16.78 miles; officers, Lieutenant Hale and Lieutenant Gaillard. Lieutenant Hale, in charge, reports:

"On Saturday morning the wires were laid to the spot selected for the seismometer. distant from the telegraph office about 900 feet on the branch road to Long Beach over which trains have been discontinued. The interval between the two tracks is used as a foot-path, and the ground is solid and well adapted to the purpose. The location is isolated.

"Lieutenant Gaillard imbedded his mercury dish firmly in the earth, obtaining an excellent contact.

"When the register recorded the explosion I marked it, and as soon as satisfied of its identity signaled Lieutenant Gaillard as agreed; the tremor reached him just after the signal. He was therefore watching intently and is satisfied as to the accuracy of his record. His records of the phases of the disturbance were marked as they came, and when compared agreed with his record.

"The clicking of the instruments and other noises about the railroad station prevented my hearing the explosion, but both Lieutenant Gaillard and Sergeant Doyle heard it, and their independent estimates placed the arrival of the sound at about a second later than that of the tremor.

"Before seeing Lieutenant Gaillard, I measured and recorded the intervals marked on the register paper. Subsequent comparison showed that our records corresponded perfectly. He observed no disturbance except that of the explosion, and there were no extra marks on the register paper.

"Following is a table showing the different intervals:

No.	Intervals.	Time from explosion.	
		M.	*S.*
1	Beginning of tremor	0	06. 59
2	Image reappears in mercury	0	24. 93
3	Probable end of disturbance produced by explosion	1	51. 01
4	End of slight uniform disturbance	2	47. 52
5	Last observation	3	24. 66

"The total length of the disturbance would therefore be 1 minute 44.42 seconds, and the interval between the explosion and the arrival of the tremor, 6.59 seconds."

Lieutenant Gaillard reports:

"The place selected for my instrument was quite hard and firm, being of yellow clay which was brought there to form the road bed. I took my pocket knife and carefully cut a hole in the earth just large enough for my artificial horizon, and ground it firmly into this hole.

"As soon as my flagman notified me that the charge had been fired, and before I had time to answer him, my wires disappeared out of sight, but not instantly. A very small time, possibly 0.2 of a second, elapsed before they disappeared, but it was too small for me to tap the key. This disappearance was followed very closely) I estimate the time as about one second, but Sergeant Doyle thinks it was between one-half second and a second) by a low rumbling sound as of very distant thunder. I recorded the reappearance of the wires by a tap number 2 on key. Between taps 2 and 3 I noticed a gradual decrease in intensity, which I have attempted to show in my curve. From taps 3 to 4 the vibrations of my cross hairs appeared almost constant, being faint but extremely rapid. From 4 to 5 the vibrations died away gradually. Few of the people around felt the shock or heard the sound, and I hardly know if I would have felt it unless assisted by my mercury as to the exact instant. I think I am safe in asserting that the shock was entirely different from any I have observed before; and on this same morning and with apparatus set up in exactly the same manner, I had observed trains, wagons, carts, and persons walking and jumping.

"As regards taps 4 and 5, they were so long after the others that it seems quite probable that the shock ended at tap 3, and that the wind blowing against my seismoscope box caused the faint vibrations I observed after it. I cannot say whether the wind was blowing at the time of these observations, but I know that a stiff and varying breeze was blowing in five minutes afterwards, and that during its continuance my mercury would not come to absolute rest."

Bay Shore, Long Island.—Distance, 36.65 miles; officers, Lieutenants Langfitt and Waterman. Lieutenant Langfitt, in charge, thus describes his station:

"I watched the register paper, and lettered the marks coming from Astoria and numbered those made by Lieutenant Waterman. Whenever he closed his circuit a line of enlisted men properly posted gave me warning. Following this nomenclature, G on the register paper marks the warning ticks; H, the explosion mark. Marks 7, 8, 9, 10, and 11 are those made by the observer during the passage of the tremor; No. 12 marks an unknown tremor. The following are the recorded intervals, correct, it is believed, to within half a tenth of a second:

	Seconds.
From beginning of explosion mark (H) to first arrival of tremor (7) (wires invisible)	12.95
From first arrival of tremor to when wires became visible again (7*e*)	0.50
From this last point to supposed end of tremor (10), (the disturbance reported as uniformly subsiding)	34.63
From supposed end of tremor to point of absolute rest of mercury (11)	65.50
Total duration of tremor to supposed end	35.13
Total duration to point of absolute rest	100.63

"It would seem that these results as to duration are liable to error from at least two causes, one being the reflection of the mercury from the sides of the vessel, and the other due to wind shaking the trees in the vicinity. The instrument was placed about 400 feet from the railroad track, in a piece of woods composed of second-growth trees of 20 to 30 feet in height, with underbrush between them. The soil was sandy. The top loam was removed to a depth of 6 or 8 inches, and the mercury dish was placed on the more compact soil beneath. There was no appearance of rock anywhere in the vicinity. The surrounding country had a very gentle and uniform rise from the shore. Lieutenant Waterman reports that the wind shaking the trees in the vicinity rarely left his mercury entirely at rest. The tent was not used. All light was excluded from the mercury dish, except that coming through the observed telescope."

Lieutenant Waterman, who used the seismoscope, reports:

"I made numerous useless marks before the disturbance due to the explosion arrived. This latter however was evident when it came.

"The plane of my instruments was nearly at right angles to the line joining the station with Astoria. All light, except that coming through the telescope whose field of view I was to observe, was cut off from the mercury by a paper covering. The reflection of this field thus stood out brightly on a dark background.

"The first shock due to the explosion was so violent that I distinctly heard the mercury splash against the side of the dish. Mark No. 7 of the register corresponds to this time. I held the key down for a time since determined as one-half a second. During this half a second I thought I could distinguish at least three successive waves. The second one of these appeared to me to give the maximum displacement. Though the cross wires of the observed field became entirely invisible, the bright spot surrounding them was never entirely out of sight.

"I have designated the end of mark No. 7 as No. 7*e*.

"Just after 7*e* the crosswires became visible, and the displacement had fallen to about one-half of its maximum value. From this point the displacement decreased uniformly to mark No. 10, which marks its apparent termination. A curve of the varying displacements, corresponding to the different register time marks, would have a cusp point and maximum ordinate not more than a quarter of a second after the first arrival. At the end of one-half a second, the ordinate would be about one-half of the maximum displacement. From this point to mark No. 10, a period of 34.6 seconds, the curve would assume the form of a right line, its ordinates uniformly decreasing until zero at the time corresponding to mark 10.

"Mark No. 10 of the register paper indicates a position of supposed rest. The shaking of trees in my vicinity rarely left the mercury entirely stationary. Mark No. 11 corresponds to a position of entire rest.

"The numbering employed above corresponds to the numbers placed after the marks on the register paper by Lieutenant Langfitt, the electrician."

Patchogue, Long Island.—Distance, 48.52 miles; officers, Lieutenant Spencer and Lieutenant Zinn. Lieutenant Spencer, in charge, reports:

"My observing station was alongside (east of) a creek flowing through a swamp, and several locations tried proved so unstable as to be worthless. The station finally selected was about 120 yards east of the creek mentioned, and about 300 yards north of the railroad.

"The mercury was constantly watched from the time of Lieutenant Zinn's receipt of directions to get ready (about 10h. 50m. 75th meridian) until the receipt of a message from him that the chronometer was out of circuit—a period of one-half hour.

"During this time nine (9) signals were sent, four before the register was started. These signals marked the beginning and maximum of an increased vibration (there was a constant movement of the mercury), the settling of which was so gentle as to prevent a notation of the end. Two more signals marking similar epochs were recorded. These signals were sent because of a doubt as to the vibrations reaching me with any marked intensity. The amplitude of vibration was in all cases small, not over three times the apparent diameter of the reflected wires.

"The true shock was unmistakable, the wires disappearing or seen only in their extreme positions near the edge of the field of view. My impression is that they moved over about three-quarters of the field of view and attained this maximum separation before I was even aware of a beginning.

"The register firing time was 12h. 35m. 54.8s.; the beginning and apparent maximum of vibration, 12h. 36m. 10.2s.; the appearance of the wires within easily observable limits (say a total amplitude of ten times the diameter of the reflected wires), 12h. 6m. 31.1s.; the return to a normal state, 12h. 37m. 04.1s.

"It is thus seen that the shock reached Patchogue from Flood Rock in 15.4 seconds; that the mercury remained violently agitated for about 20 seconds; and that it resumed its normal state about 30 seconds thereafter.

"To Lieutenant Zinn credit is due for the perfect operation of the electrical apparatus; to the enlisted men of the party for good behavior and efficient service. My thanks are extended to the station agent and the operator at Patchogue for their voluntary assistance in perfecting our arrangements throughout."

Lieutenant Zinn reports his operations as follows, sufficiently showing that the electrical arrangements worked perfectly under his careful management:

"I acted as electrician of the party sent to Patchogue, L. I., under charge of Lieutenant Spencer.

"About 8 a. m. I made the electrical connections as shown on the accompanying diagram, except those at the observer's key, and set up 5 Grove cells except putting in the nitric acid; this I did about 10 o'clock. The circuits were then tested—the office circuit by putting my relay in a derived circuit of the main line, and the outer one by closing the observer's key; both worked properly; the register gave clear strong impressions; the paper moved smoothly.

"After I received the telegram to get ready, I inserted the relay in the main line. In a few moments the second ticks began to come. I tried the register again and found it worked all right. When the seconds were interrupted by a series of dashes, I started the register; the dashes were recorded clearly. I watched the paper closely, marking all extra ticks by letters near the margin of the paper, and rolling it up as it came out. When the ticks ceased, I stopped the register and broke the connections."

Goat Island, Newport, R. I.—Distance 144.89 miles. Commander W. T. Sampson, U. S. Navy, informs me that he observed a mercury seismoscope, placed on the concrete basement floor of a building of the Torpedo Station, with a telescope having a magnifying power of about 15 diameters. The earth wave was unmistakable. It arrived at 11h. 14m. 49s., and ceased at 11h. 16m. 03s., mean solar time of the 75th meridian. The error of the chronometer was determined with precision by direct comparison with the time signal sent at noon from the Naval Observatory at Washington. He observed only one maximum during the passage of the waves.

Harvard College, Cambridge, Mass.—Distance 182.62 miles. The observations at this station were reported to the American Academy of Arts and Sciences, by Prof. W. A. Rogers, who made them. A résumé of his paper appeared in *Science*, No. 142, Vol. VI, and also in the *Daily Advertiser*. From these reports the following abstract has been compiled:

Professor Rogers observed a well-defined streak upon the surface of a dish of mercury, placed on the bed of the comparator in the cellar of the west wing of the observatory, which is separated from the building and is very stable. A sharp point of this streak was watched through a microscope, having a quarter of an inch objective, with a magnifying power of about 750 diameters.

Although annoyed by the passage of an ice wagon at about the same time, he thinks there can be no reasonable doubt that the reported tremors were the result of the explosion. The first occurred at 11h. 17m. 30s.; a second and more violent commotion was observed 10 or 15 seconds later, when the rumble of the ice wagon was heard at a distance of about 1,000 to 1,300 feet. A third even greater disturbance occurred at a like interval after the second; at 11h. 18m. 15s. the entire surface of the mercury under the objective appeared to sway back and forth over a space certainly as great as one five-hundredth of an inch. This continued 8 or 10 seconds. and at the end of about 20 seconds there was an almost entire subsidence of the commotion. From this instant the recurring disturbances' gradually diminished, and at 11h. 20m. they had entirely ceased. At this time the ice wagon was directly opposite the observatory. These times are all referred to the standard 75th meridian.

On the following day, an ice wagon was started from nearly opposite the observatory and driven rapidly away. Only a very slight tremor of the mercury was observed while the cart was traversing a distance of 750 feet, and it then ceased.

Professor Rogers states that the waves of disturbance certainly increased in amplitude until 11h. 18m. 15s., and gradually diminished after that time; the intervals between waves appeared to be about 15 seconds. He is not quite certain whether there were three or four waves preceding the one having the greatest amplitude. The direction of movement of the streak was on a line about 15° from the meridian; *i. e.*, north of east and south of west.

West Point, N. Y.—Distance 42.34 miles; officers, Lieutenant Mott, Eighth Infantry; Lieutenant Beach, Corps of Engineers; Lieutenant Stuart, Ordnance Department. These officers kindly co-operated with us, thus permitting a comparison between the rate of transmission through the rocky strata extending northward from Astoria, and that through Long Island drift.

Lieutenant Mott reports:

"I had three seismometers arranged for these observations. Numbers 1 and 2 were placed on the tops of the transit piers, and No. 3 was mounted between, with the mercury resting on the pier foundation where the Nadir basin of the transit belongs. They were all sufficiently sensitive to show the jars produced by striking on the rock with a crowbar 200 feet away. Passing trains gave no perceptible tremors. Electrical connections were so made that the chronometer used at the scene of the explosion recorded on the observatory chronograph. I observed with instrument No. 2, and held the key for breaking local current to chronograph; Lieutenant Beach, Corps of Engineers, observed with No. 1; and Lieutenant Stuart, Ordnance Corps, observed with No. 3.

"I made the record of my own observations on the chronograph; and to enable the others to get the time, I had Mr. Grunow and the soldier assistant alternate in calling out the seconds, as they were ticked off by the observatory clock.

"We commenced observing at 11 o'clock. After observing some 10 or 15 minutes, the reflected image in my apparatus suddenly commenced moving from side to side with such rapidity as to give a confused and rapidly vibrating field of view. The extent of motion was probably a tenth or twelfth the field of view.

"These vibrations commenced suddenly, and continued to flow along uniformly without breaks or interruptions for about a minute, and then to gradually and uniformly grow less and less until all became perfectly quiet.

"I observed no noise during the presence of these tremors. Young Mr. Grunow, who was in the basement of the building, heard a noise about quarter after eleven which he took to be the rumbling of a train, but after thought it might be connected with the Hell Gate explosion. Professor Bass also states that while in the academic building he heard a rumbling which brought to mind the explosion, and upon looking at his watch fixed the time at 14 or 15 minutes after eleven. This rumbling was also heard at Glen Cove, L. I.; and, I believe, by Mr. O. H. Rockwell, at Tarrytown, on the Hudson.

"The clock was set going for this occasion; its error was not determined, as I thought the comparison with the Flood Rock chronometer would be sufficient. I have reduced the clock times to those of the chronometer; and the results of the observations, and the power of the observing instruments, I give in the following tables. I also send copies of reports of the other two observers.

TABLE I.—*Magnifying powers and field of view of observing instruments.*

	Magnifying power.	Field.	Observer.
No. 1	16	2° 7′	Lieutenant Beach.
No. 2	31	1° 5′	Lieutenant Mott.
No. 3	36	0° 46′	Lieutenant Stuart.

TABLE II.—*Result of observations.*

	Mott.	Beach.	Stuart.
	h. m. s.	*h. m. s.*	*h. m. s.*
Tremors end	12 37 24.2	12 37 15.9	12 37 38.0
Tremors begin	12 36 8.4	12 36 5.7	12 36 5.7
Instant of explosion	12 35 54.8	12 35 54.8	12 35 54.8
Interval	13.6	10.9	10.9
Duration	1 15.8	1 10.2	1 32.3

12h. 37m. 57s. chronometer } ticked together.
11h. 16m. 29s. clock }

Clock.	Chronometer.
11h. 14m. 38s. =	12h. 36m. 5.7s.
11h. 15m. 48s. =	12h. 37m. 15.9s.
11h. 16m. 10s. =	12h. 37m. 3.8s.

"In adjusting these intervals I have to say that my record of first arrival being recorded on the chronograph is necessarily late. Some little time is required to settle in your mind that the tremors are certainly present, in addition to the time taken to reach and press the key. I considered when I made the record that I was probably a second late in making it. The other observers had the time called off, requiring them to make a sort of mental estimate of the time of beginning; and I believe the tendency to be to go too far back, that is, make the instant too early. Mr. Stuart in his report places the instant between the 38th and 39th seconds, and in taking as he does the 38th as the instant, he anticipates the event by some fraction of a second. In my report to Colonel Michie I arranged the results making the interval 11.8 seconds. I believe a better adjustment would result by giving my observations twice the weight of each of the others, thus making the interval 12¼ seconds."

Lieutenant Beach reports:

"The vibrations began at 11h. 14m. 38s., and reached the maximum almost immediately, and continued uniformly until 15m. 20s., when they began to decrease until at 15m. 33s. they were quite faint; and from this point they were merely noticeable until 15m. 48s., when nothing more could be perceived. The maximum vibration was about one-fifteenth of the radius on each side, and the changes at 15m. 20s. and 15m. 33s., were not gradual but comparatively abrupt."

Lieutenant Stuart reports:

"My record of time was taken from the count of the assistant. Very minute but sensible tremors occasionally occurred, but suddenly the wires disappeared from view, and in their place was a dimness caused by the rapidly vibrating reflection from the mercury surface. This occurred between 11h. 14m. 38s. and 14m. 39s., and the disturbance seemed to reach its maximum value at once, and to continue with undiminished intensity till 15m. 20s., after which it decreased uniformly till, at 15m. 47s., it had nearly disappeared; but I believe I observed a faint tremor, not apparent before the disturbance began, till 16m. 10s. The amplitude of the vibrations was about one-tenth the radius of the field of view on each side of the center.

"The vibrations above described were very distinct, and their amplitude was probably one hundred times as great as that of the ordinary tremors observed before and after this occurrence."

Litchfield Observatory of Hamilton College, Clinton, N. Y.—Distance, 174.37 miles. Prof. C. H. F. Peters, the director, has kindly furnished me with a copy of the report upon his observations, to which the great distance of his station and his well-known skill as an observer give an exceptional value. He states:

"I made arrangements for observing the time, if any effect should be sensible here, by the trembling produced on the surface of quicksilver. It seemed to me necessary not to rely upon one single apparatus, in order to make sure whether any motion that might be perceived was accidental to the apparatus, or produced by a shaking of the soil of wider range. I could dispose two vessels of mercury on two different isolated piers. These piers are imbedded to the depth of several feet in a very hard, richly agglomerate-bearing clay that overlies here the so-called red shale rock.

"Outside disturbance, as in the cities (from wagons, &c.), was not to be feared in our comparatively quiet country place. The nearest railroad is 1¼ miles distant, and no trains were passing at that hour.

* * * * * * *

"By providing the transit with a Bohnenberger eye-piece, and pointing it to the nadir observing the reflected wires, we had the one apparatus. The transit (made by Wurdemann) has an aperture of 2¼ inches; its magnifying power with this eye-piece is about 45. The mean time clock, Bond No. 185, stands in convenient neighborhood for seeing and hearing the seconds' beats. My assistant, Mr. Charles A. Borst, observed here.

"Another basin with mercury was placed upon the pier of the 4-inch Steinheil refractor in the southwest dome, the entrance to which is from a computing room that on the opposite side has a door leading to a small cabinet. To the post of this latter door a telescope of 2 inches aperture, magnifying power about 25, was fixed so that the light of a lamp reflected from the mercury basin could be observed through it. It was inclined under an angle of 7½° to the horizon. The eye-tube could not be drawn out quite sufficiently for a sharp focus at that distance, but experiments showed that a very slight knocking of the pier with a pencil was perceptible by one or more neat black waves running through the field. Near me I had the sidereal chronometer, Bond No. 207, that beats half seconds.

"The door between the transit and computing rooms was closed, but we were in calling distance, so that when one of the observers needed to rest his eye for a moment, or to check his count of the beat, the other was attentively looking into his telescope. This provision proved very useful on account of the prolonged time, as we were at our posts beginning to look a little before $11^{h}\ 0^{m}$.

"The mercury had been quite calm all the while, until a first wave was seen rushing through the field at $12^{h}\ 31^{m}$ 103 beats, chronometer (precisely at the beat), followed by several others in quick succession. Again at $12^{h}\ 32^{m}$ 80 or 81 beats, chronometer, I observed a strong quivering, a more irregular and confused motion of the mercury.

"Mr. Borst noted a sudden disappearance of the reflected image of the wires between the clock beats 30^{s} and 31^{s}, so that his observation was $23^{h}\ 12^{m}\ 30.5^{s}$ o'clock.

"At the same time the patch of light arising from the illumination of wires through the eye-piece and diffused reflection from the mercury surface began to move, and he saw it swinging to and fro for some little while.

"Chronometer and clock were compared by coincidence of beats as follows:

Before: $2^{h}\ 53^{m}\ 35^{s}$ mean time clock $= 12^{h}\ 12^{m}\ 53^{s}$ siderial chronometer.
After: $23^{h}\ 20^{m}\ 35^{s}$ mean time clock $= 12^{h}\ 39^{m}\ 57.5^{s}$ siderial chronometer.

"From this the chronometer time of my observation may be reduced directly to clock time, and we find $12^h\ 31^m\ 51.5^s$ chronometer $= 23^h\ 12^m\ 30.3^s$ clock.

"The agreement with Mr. Borst's observation, viz, $23^h\ 12^m\ 30.5^s$ clock, is so close that in part it must be attributed to chance; we take the mean, $23^h\ 12^m\ 30.4^s$ clock, which hardly can be in error by more than $\pm\ 0.5^s$.

"The clock has a very small rate, and its correction to mean time at $23^h\ 0^m$ was $+27.43^s$. This gives for the time of the observation, $23^h\ 12^m\ 57.83^s$ Hamilton College mean-time, and as our longitude is 5° 1′ 37.45″ from Greenwich, $11^h\ 14^m\ 35.3^s$ standard time. There is no reason to attribute the commotion observed here to any local cause; it seems to have been the explosion of Flood Rock, at the distance of 170 miles."

Upon receipt of this paper I wrote to Professor Peters to request further information as to the nature and duration of earth tremor, which the intermediate observations at West Point had left no doubt was caused by the explosion. He replied:

"In answer to your last inquiry, I make the following statement: After having written down 3 (103) I continued to count the chronometer beats without removing my eye from the telescope, and saw several more waves passing through the field, following the first, of which the time was noted; in the next few (perhaps 10) seconds I heard my assistant in the adjoining room breaking out in loud astonishment; it was the swinging to and fro of the reflex of light, following after the sudden disappearance of the reflected wires, that convinced him Hell Gate was there and caused the exclamation. I lost thereby my count, and had to look down at the chronometer, which time I used for writing down also the minute. From 10 to 15 seconds I may have thus lost. Putting my eye again to the telescope, the mercury seemed to be calm; but while I continued to look my eyesight got dim, as I fancied; I winked and squeezed the eyelids together for seeing more distinctly; and after a little, that is to say, after several seconds, I became convinced that the mercury surface was in uproar. I noted the time of this, when it appeared to be at its height, as 80 or 81 beats. This instant, as you see, is therefore only a rough estimate. How long the motion of the mercury continued *after* that I did not wait to see; that it was there already, perhaps some 10 seconds before, though less strong, I believe. There was certainly a lull in the motion between $31^m\ 103^b$ and $32^m\ 80^b$ chronometer, but how long I cannot tell; it was less than 49 seconds anyhow, and may have been 30 seconds or even 20 seconds. Much importance, besides, cannot be attributed to the duration of this lull, as that depends upon the length of time the mercury remains oscillating after the receipt of the shock. I am unable to give more precisely the *beginning* of the second motion, which was much heavier than the first, as I have described."

DISCUSSION OF THE RESULTS.

To avoid any possible cavil as to the element of distance, I requested an accurate statement from the Coast Survey Office, forwarding a tracing of Colton's large scale map of Long Island to aid in identifying from the neighboring shore line the exact position of the railroad stations occupied by my parties. Professor Schott kindly furnished the following table, and also the tracing which has been used in preparing Plate III:

Stations.	Geodetic position of observing stations.		Distance to Flood Rock in kilometers.	Azimuth of direction from Flood Rock to station, counted from S. round by W.
	Latitude.	Longitude.		
	° ′ ″	° ′ ″		°
Flood Rock, New York	40 46 41.4	73 56 17.6	....	....
Pearsalls, Long Island	40 39 18	73 39 45	27.01	300.
Bay Shore, Long Island	40 43 28	73 14 36	58.99	275.
Patchogue, Long Island	40 45 51	73 00 49	78.08	270.
Goat Island, Rhode Island	41 29 36	71 19 39	233.17	249.
Harvard College Observatory, Massachusetts	42 22 53	71 07 44	293.99	231.
West Point Observatory, New York	41 23 28	73 57 21	68.08	178.
Hamilton College Observatory, New York	43 03 17	75 24 21	280.62	154.
Princeton College Observatory, New Jersey	40 20 54	74 39 17	77.20	52.

"Accompanying this is a tracing of the rock and of the adjacent shore, taken from a new topographical survey just completed."

The mercury seismoscope (with a telescope of sufficient power) indicates accurately the instant of the arrival of the earth wave; but it fails to reveal with precision the duration of its passage, because an unknown and very sensible time is required for the mercury to come to rest after all motion of the earth has ceased. The galvanometer observations at Willets Point were ordered to determine, if possible, an empirical correction for this defect. The mercury there was agitated for 80.5 seconds; the galvanometer (see Lieutenant Gillette's report above) indicated that the earth was in motion for 62.5 seconds. This points to a subtractive correction of about 18 seconds to eliminate the time lost in coming to rest. As the observers report that the earth tremor appeared to subside uniformly and gradually, and as they all used similar mercury vessels, I have applied this correction where the telescopes did not differ materially from 20 in magnifying power. These figures are presented in the sixth column of the following table, which exhibits in a consolidated form the more important of the data given above.

Data at the Flood Rock explosion.

Stations.	Distance from Flood Rock.	Magnifying power of telescopes.	Earth wave.			Velocity of transmission in miles per second.	Remarks.
			Arrived in.	Mercury in agitation.	Earth tremor lasted.		
EASTERLY COURSE THROUGH DRIFT.	*Miles.*		*Sec.*	*Sec.*	*Sec.*		
Willets Point	8.33	14	8.5	80	.....	0.98	By mercury.
			8.8	.....	62	.....	By galvanometer.
Pearsalls	16.78	14	6.6	104	86	2.54	
Bay Shore	36.65	18	13.0	35(?)	.....	2.82	
Patchogue	48.52	19	15.4	54	36	3.15	
Goat Island	144.89	15±	58.8	74	56	2.46	
Harvard Observatory	182.68	750	219.8	95+	.....	0.83	
NORTHERLY COURSE THROUGH ROCK.							
West Point	42.34	31	13.6	76	58	3.11	Lieutenant Mott.
		16	10.9	70	52	3.88	Lieutenant Beach.
		36	10.9	92	.....	3.88	Lieutenant Stuart.
Litchfield Observatory	174.37	25	45.0	49+	.....	3.88	Professor Peters.
		45	45.2	.....	.....	3.86	Mr Borst.

These observations indicate: (1) An extraordinary velocity of wave translation in both directions—which confirms my deduction from the Hallet's Point and certain torpedo explosions, that "the more violent the initial shock the higher is the velocity of transmission." At Flood Rock the charge was about six times as large as at Hallet's Point, and the velocity was from two to three times as great, over essentially the same route. (2) The uniformity of velocity to the northward, where the strata consists largely of homogeneous gneiss rock, and where the velocity even for 175 miles exceeded 20,000 feet per second. (3) The varying velocity which appeared to characterize the wave moving to the eastward, through the drift formation of Long Island. Here there seems to have been a gradual increase of velocity, followed by a decrease as the wave advanced—but on the whole a decidedly less rapid rate is indicated than in traversing solid rock, as might be expected in media of varying density and elasticity. The result, although not inconsistent with the Hallet's Point observations, was not discovered from them, except as to the decrease in velocity as the wave disappeared. This is the only point where the four deductions from the earlier observations are modified by this later and more accurately observed explosion (see Appendix B).

The very slow rate of movement to Willets Point is so surprising that it has received the closest scrutiny, but the evidence seems to establish its correctness. The latter rests (1) upon the determination of the absolute instant of explosion (see Appendix D); and (2) upon the observed arrival of the tremor, closely verified by the galvanometer observations. The resulting velocity is also roughly confirmed by the observations at Astoria, as will be explained in discussing the photographs.

The Flood Rock explosion appears to have caused a continuous earth tremor, which, observed under a magnifying power of about 18, lasted about one minute throughout the whole region covered by the observations, the maximum disturbance leading the advance, or nearly so, for at least 50 miles. At extreme ranges the tremor appears to have broken up into successive waves, with well-marked intervals between them. These facts, the instantaneous nature of the explosion shown by the photographs, and the varying rates of advance through strata not homogeneous, appear to warrant the conclusion that the oscillation followed different routes to any given point—some near the surface, and others at greater depths, where more dense and elastic strata produced changes in the direction of the wave front and yielded higher velocities.

The whole subject is evidently too complex to warrant definite conclusions as to the velocity of ordinary earthquake waves, where the intensity of the original disturbance must always remain unknown. The results derived by Captain Knight from his observations at Astoria are in accordance with this view. (See C.)

THE PHOTOGRAPHS.

Referring now to the photographs (see Appendix E for details), the first two views show that ignition by sympathy was transmitted so rapidly as to be practically instantaneous over the entire area of the rock, and that no failure occurred in any of the galleries. In a word, they demonstrate the entire success of this new method of ignition.

The following computation fixes the epochs of these pictures, and of the explosion itself as well, referred to the chronograph record at Astoria. The first motion of the key is taken as the zero of time:

Instant of explosion.

	Seconds.
Movement of the firing key	0.02
Action of circuit closer at Flood Rock	0.10
Explosion after first motion of key	0.12

Retardation of chronograph record.

	Seconds.
Movement of firing key (breaking circuit)	0.00
Relay armature time	0.05
Register armature time	0.10
Record after first motion of key	0.15

Hence the explosion occurred 0.03 of a second before the record—or practically at the same instant.

Time of automatic photograph.

	Seconds.
Movement of firing key	0.03
Retarding relay armature time	0.15
Drop of shutter to middle of exposure	0.13
	0.31
Deduct retardation of explosion, above	0.12
Time after explosion	0.19

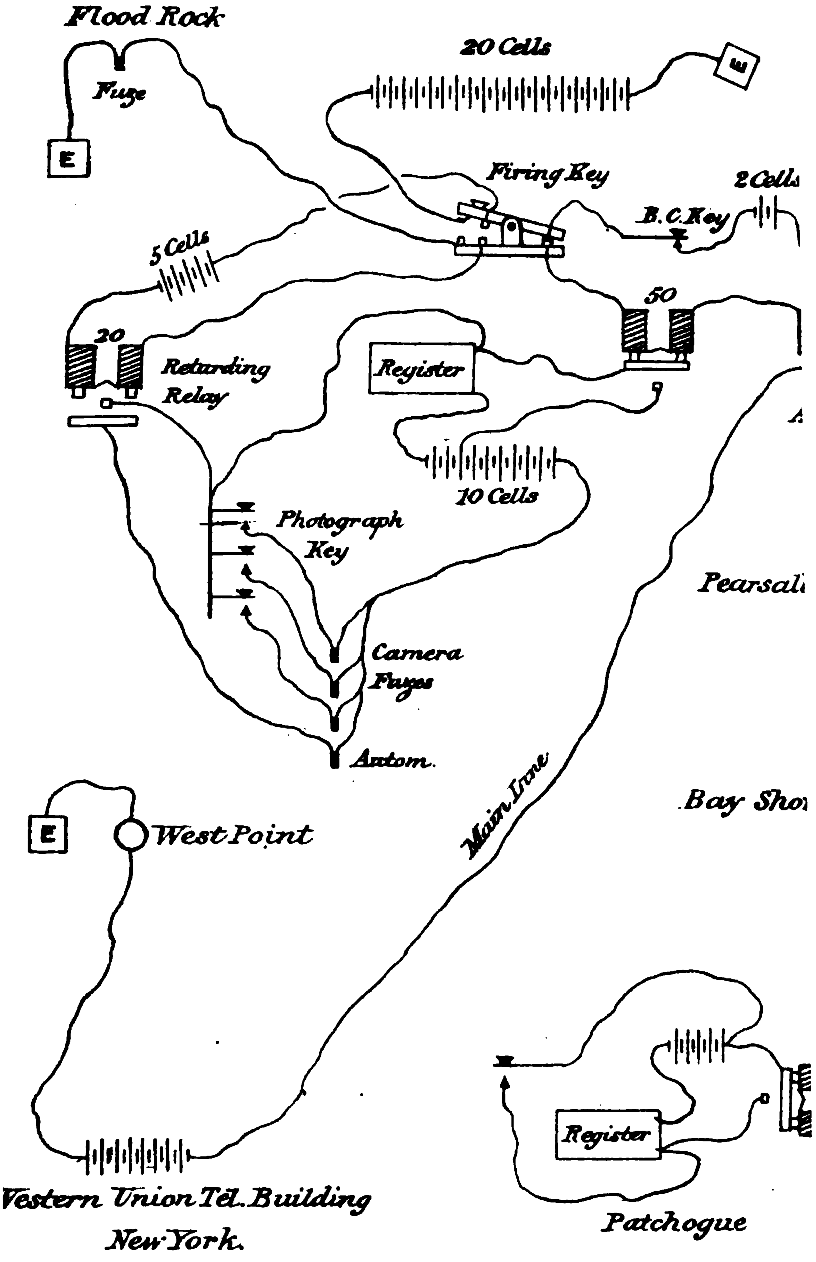
The register record shows that Lieutenant Lusk's first attempt (which failed to give a picture) was made 0.17 of a second after the automatic picture, and that his successful photograph was taken 0.25 of a second still later.

Hence the actual epochs of these pictures after the explosion, closely determined, are 0.2 and 0.6 of a second, respectively. The epoch of Sergeant von Sothen's picture, roughly deduced from the increase in height of the jet as compared with those of the other two, is about two seconds. The extreme height was reached probably about a second later.

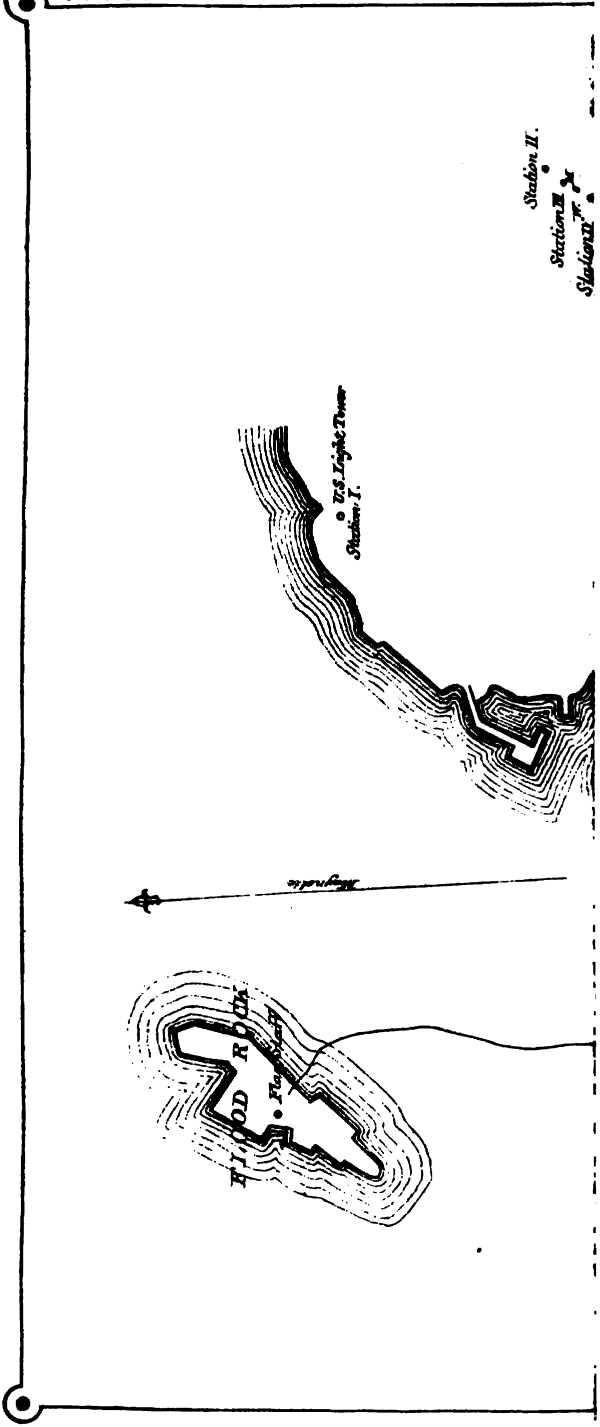
An interesting result was obtained, accidentally, by the method used for recording these times. The actual chronograph record was as follows: First indent (recording automatic photograph), a smooth line .13 of a second long; interval, .06 of a second: second indent, three dots covering .11 of a second; interval of .12 of a second; third indent, three dots covering .13 of a second. The length of the second's mark on the fillet was about 1 inch, rendering these small periods easily measurable. They indicate that the first picture was taken at or before the arrival of the earth tremor, and that the others were taken during its passage. The distance to the rock being about 1,100 feet, this would suggest that the wave was moving with a velocity of about 1 mile per second, or much less than that with which it reached all the stations beyond Willets Point. But little weight can be accorded to this inference, because the wave velocity is much too high, and the instant of explosion too uncertain, to permit a precise determination of so small a difference of time; still the result, so far as it goes, is confirmatory of the Willets Point record, and of a rate of horizontal advance in the vicinity of the mine much more sluggish than at greater distances.

Very respectfully, your obedient servant,

HENRY L. ABBOT,
Lieut. Colonel of Engineers,
Brevet Brig. General, U. S. A.


Flood Rock
Fuze
E
20 Cells
E
Firing Key
2 Cell
B.C. Key
5 Cells
20
Retarding Relay
50
Register
10 Cells
Photograph Key
Camera Fuzes
Autom.
Pearsal
Main Line
Bay Sho
E
West Point
Register
Patchogue
Vestern Union Tel. Building
New York.

FLOOD ROCK EXPLOSION



H Ex1 pt2 v2 49 2

A. -SHOCK OF THE EXPLOSION AT HALLET'S POINT.[*]

[By Bvt. Brig. Gen. Henry L. Abbot, Major of Engineers.]

In June, 1876, Prof. J. W. Mallet, of the University of Virginia, addressed a communication to the Secretary of the Smithsonian Institution, suggesting that advantage should be taken of the great blast at Hallet's Point to revise the experimental results obtained by his father and himself many years ago respecting the rate of transmission through the earth's crust of an artificially produced impulse analogous to an earthquake shock. Professor Henry referred this paper to the Chief of Engineers, who forwarded it for report to General Newton, in charge of the works at Hallet's Point. That officer stated that he would cordially co-operate in the proposed observations, but that from want of time he could not give them personal attention. General Humphreys then issued instructions placing the matter in my charge, and authorizing the employment of the officers and enlisted men of the Battalion of Engineers, and the use of such instruments, insulated wire, &c., as might be available at the School of Submarine Mining at Willet's Point.

My attention had already been drawn to the subject in a general way by the vibrations produced by ordinary torpedo explosions, which are often noticeable at distances exceeding a mile. Professor Mallet kindly loaned several volumes containing reports of his father to the Royal Society upon Earthquakes, and verbally explained the seismometer used in the investigation mentioned in his communication to Professor Henry. The same general method has been carried out in the measurements upon the Hallet's Point explosion, with such improvements as the progress of science has suggested.

PRELIMINARY PREPARATIONS.

No funds were available for the purchase of instruments; but the Engineer Depot contains many worn out and condemned articles, and from them, with the assistance of Captain Livermore, the seismometers described below were improvised. The needful registers, batteries, relays, keys, chronometers, &c., and the means of accurately adjusting and rating them were on hand, and require no special mention.

SEISMOMETERS.

If an ordinary artificial horizon of mercury be placed on solid ground remote from the vicinity of trees, passing vehicles, or other causes of accidental vibrations, and the reflection of some convenient object from the surface of the mercury be closely watched, any tremor in the latter is instantly detected. By using a microscope the delicacy of the instrument is increased; and by varying the magnifying power, a wide range of sensitiveness is secured. Such a variation is desirable when stations at different distances are to be occupied, because an unnecessary sensitiveness increases the danger of losing the observation from an accidental tremor.

Two kinds of these seismometers were employed. One, which will be designated as type A, was made by attaching a black silk thread to one of the glasses of the artificial horizon cover, and observing its reflection by a sextant telescope mounted on a small tripod. The magnifying power employed in this case was about six diameters.

For more distant stations, the telescope of a railroad transit, having a magnifying power of about 12 diameters, was used, and, to avoid placing it at an inconvenient distance from the mercury, the reflection of the cross hairs of another similar telescope with the eye-piece removed was observed. This type will be designated as B. A man walking at a distance of 10 feet, or a horse trotting at a distance of 300 feet, shakes the ground sufficiently to be readily detected with this arrangement.

EMPIRICAL FORMULÆ AND CONSTANTS.

To select stations for the observers judiciously, in the absence of any data upon an explosion of so exceptional a character, a rough investigation of the laws governing the transmission of such impulses was undertaken. Denoting by S the tremor causing the minimum disturbance of the mercury, which could be detected by the type of instrument to be employed; by D, the distance separating the instrument from the initial disturbance causing S; and by C, the weight of the explosive, it is plain that we have the equation:

$$(1) \qquad S=\frac{f(C)}{f(D)}$$

Experiments were first directed to determining the function of D entering the second member. To do this, it was necessary to find the values of D corresponding to a series of artificial disturbances that could be precisely regulated, and that were of the same nature as that resulting from the explosion, which, since dynamite was to be used, might safely be assimilated to a blow. No better plan suggested itself than to make use of the fall of a heavy body through small known heights, in which case the shock might be assumed to be directly proportional to the work performed, *i. e.*, the height.

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[*] Read before the National Academy of Sciences on October 18, 1876, and before the Essayons Club of the Corps of Engineers on November 14, 1876.

Accordingly a cart was so arranged that a 13-inch shot, weighing 283 pounds, could be dropped precisely 2 feet or 4 feet, as desired, giving a blow, respectively, of 566 and 1,132 foot-pounds. Instruments of type A and B were placed side by side upon a solid road, and the cart was moved further and further until the tremors caused by dropping the shot through these heights could only be just perceived, thus giving for each instrument two values of D corresponding to known shocks. A path running near sustaining walls, and over a drain 20 feet below the surface, gave another set of numerical values differing slightly from the first, but following the same law. Other values were found by dropping stones of known weight through known heights.

A discussion of these observations indicated that where the *vis viva* of the shot at impact varies proportionally with $D^{1.2}$ similar tremors affect the seismometer. Hence:

$$S=\frac{f(C)}{D^{1.2}} \qquad (2)$$

The form of the function of C could best be determined by firing small charges of dynamite, bedded in the ground, at different distances, and noting when they gave a tremor just perceptible. This was done with the following results:

Type A just detects the tremor due to 2 ounces at 660 feet, failing for 1 ounce, and plainly detects the tremor due to 8 ounces at 1,480 feet, failing with a much less quantity.

Type B plainly detects the tremor due to 2 ounces at 1,480 feet, failing for 1 ounce. A cartridge of 8 ounces gives, at this distance, a continuous vibration lasting about 2 seconds, and 12 ounces one lasting for 3¾ seconds. At 660 feet the shock of 1 ounce is very noticeable.

These figures, considering the rough nature of the data, point to the square root of C as the desired function, giving the law:

$$S: \frac{\sqrt{C}}{D^{1.2}} \qquad (3)$$

Hence, substituting the numerical values found for the two types of seismometer employed, the units being the mile and the pound, we have:

$$\text{(4)} \quad \text{Type A} \quad D=\sqrt[1.2]{\frac{\sqrt{C}}{3.26}}$$

$$\text{(5)} \quad \text{Type B} \quad D=\sqrt[1.2]{\frac{\sqrt{C}}{1.63}}$$

These empirical formulæ were roughly tested by the vibrations caused by the torpedoes exploded this summer during the prosecution of the submarine mining trials now in progress at Willets Point, namely:

(1) A charge of 200 pounds of dynamite, submerged 30 feet under an iron target, was fired on August 18. By Eq. (5) it should give a noticeable tremor at a distance of 6 miles. Captain Livermore distinctly detected it with an instrument of the B type at a station 5 miles away.

(2) A charge of 100 pounds of dynamite, submerged 12 feet, was fired on September 2. It should have been perceived, according to Eq. (4) and (5), at extreme ranges of 2.5 miles and 4.5 miles, respectively. Observers at 2.3 miles and 4.1 miles failed to detect it, but the exact instant of the explosion was unknown to them, and the wind and other conditions were unfavorable to so delicate observations on that day.

In fine, then, I considered that a more judicious selection of stations for the great blast could be made by regarding the indications of these formulæ than by any other method.

SELECTION OF STATIONS.

As the charge at Hallet's Point was to be about 50,000 pounds of dynamite, the formulæ indicated 33 miles and 59 miles, respectively, as the distances for the extreme stations for seismometers of types A and B.

It was needful, however, to bear in mind that the mine was made up of thousands of small charges, and that this distribution might probably reduce the tremor. This fact, together with the importance of securing distinct observations at the few stations it would be possible to occupy, led me to prefer to err on the safe side.

The geographical situation of Hallet's Point with respect to land and water was also to be considered, since it was desirable to detect any difference due to the nature of the route traversed by the vibration.

The telegraph system in the vicinity was also a matter of primary importance. Upon Long Island this is under the control of the Western Union Telegraph Company, but the railroad companies have the right to send train messages. Both corporations freely extended every facility in their power without charge, doing, indeed, more than I had asked to promote the excess of the experiments. To the Western Union, particularly, acknowledgments are due, for not only was the assistance of the operators freely granted, but special line-men, even, were sent out to insure the good condition of the wires.

Finally, five stations were selected. Three, Fresh Pond Junction, Jamaica, and Springfield Junction, were on a land route extending in a southeast direction across Long Island, and were in telegraphic communication with Astoria, near Hallet's Point. Willet's Point lay to the eastward, nearly in the direction of East River, and offered a good water route. Lastly, West Point, to the north, was distant 52 miles—*i. e.*, was nearly at the extreme range indicated by the formula for the most sensitive seismometer. Lieutenant Bass, Corps of Engineers, stationed at that post, kindly volunteered to observe there with a very powerful telescope, but the storm compelled him to change his plan, and to use one of type A, which, as predicted by the formula, failed to detect any vibration.

TIME DETERMINATIONS.

The plan employed by General Newton to explode the mine was the following: The charges were divided into 23 groups, for each of which a separate voltaic battery was provided. The circuits of these batteries were each complete except at one point. Here breaks existed between a set of mercury cups on a table and corresponding brass points on a drop above. This drop was held up by a cord, suspended from a small can containing a charge of dynamite and a fuze. When, at the appointed time, the latter was exploded by an auxiliary battery the drop fell, and, simultaneously closing all the circuits, fired the mine. General Newton kindly provided an extra mercury cup and point for my use, and thus gave me an opportunity of causing the explosion to automatically register itself at the three stations to which an electrical circuit could be carried.

All the wires on Long Island are worked by batteries in the Western Union building in New York City. A multiple cable carries the circuit across East River, near Hunter's Point, and one core is thence extended in a loop to Astoria to work that office. For my observations the current was sent from New York to Astoria, and thence along a single wire to the three inland stations selected, viz: Fresh Pond Junction, distant about 5 miles; Jamaica, distant about 9 miles; and Springfield Junction, distant about 13 miles from the mine. The wire was put to earth beyond the instrument at the latter station.

At each of these three stations the line-wire passed through the coils of a relay arranged to close a local circuit when the current passed. These local circuits each contained a battery and a Morse register. Independent circuits containing the same battery and register were arranged at each of the stations, to be closed at will by a key in the hand of the observer at the seismometer, who took post at the best position in the vicinity for obtaining good results, care being taken to secure a solid support for the mercury and the minimum danger of interruption from passing vehicles, &c.

At Astoria the main-line circuit was worked like a local by a special battery; that is, it was attached to the contact points of a relay, and remained open except when this relay was acted upon by an auxiliary battery. The latter battery (10 cells Leclanché) was placed at the firing station, with one pole to earth. The other pole was connected to a line of insulated torpedo cable, laid on the ground for the purpose. The current on leaving the battery passed first through a break-circuit plug in the hands of the observer; thence through the coils of a relay, working a local circuit for recording the exact instant of the explosion; thence to the mercury cup at the mine, where was situated the break, to be closed by the drop at the explosion; thence to the coils of the relay at the Astoria office, and thence to earth.

The break at the drop was thus the only one in this auxiliary circuit, and it was closed by the same motion and at the identical time when the firing batteries exploded the 3,680 fuzes. The effect was instantly to work the two relays of the auxiliary circuit. The one at the firing station registered the time; the one at the Astoria office closed the main line, and thus sent a current from the New York battery through the relays at the three stations, making a mark on each of the register papers. As soon as the observer at the firing station perceived that the mine had exploded he withdrew the break-circuit plug, all the relay contact points on the main line opened, and the register papers were each ready to receive the marks caused by the key of the observer at the adjacent seismometer as he noted the tremor of the mercury.

By this system the explosion recorded itself at each of the three stations with only the error due to three armature times, which probably did not exceed two-tenths of a second, and even this small error was balanced by the time spent by the observers in closing their keys. Great care was given to securing a regular movement of the paper on the registers, and elaborate measurements, made just before and after the explosion, show that this object was attained with a probable error not in any case exceeding two-tenths of a second. The most exact accuracy is, therefore, claimed for these measurements.

The stations at Willets Point and West Point, not being on telegraph circuits, required different arrangements. As no tremor was detected at the latter place, the details for it possess no interest. Those for Willets Point, however, are important, because the rate of transmission noted is surprising. Two good sidereal chronometers were employed. One is permanently kept in the astronomical observatory there, and its rate is known. The other was carried very carefully by boat to and from Hallet's Point, where it was used in making the absolute time marks on the register paper at the firing station. Careful comparisons were made at 6 a. m. and 6 p. m. of the day of the explosion and again at 10 a. m. of the following day. They showed a discrepancy in the rates of only .4 seconds in twelve hours, proving that the latter remained sensibly unchanged during the three hours intervening between the blast and the second comparison.

The observations at Willets Point were made in the observatory with a sensitive seismometer and Morse register, the absolute time being directly referred to the standard chronometer. By this method a very close measurement of the time required for the tremor to pass to Willets Point was secured, the error being probably a small fraction of a second.

DETAILS OF THE OBSERVATIONS.

The mine was exploded on September 24, 1876, at precisely 2h. 50m. 12.6s. of New York mean solar time. This determination is correct within a small fraction of a second, and may serve to give value to observations made by other observers, who took the precaution to accurately note the instant of feeling the tremor and to ascertain the error of their time-pieces.

The following is a summary of the reports of the officers of Engineers who made the observations at the several stations, arranged in the order of their increasing distances from the mine.

LIEUTENANT YOUNG, AT FRESH POND JUNCTION—(distant 5.134 miles from the mine.)

By an unfortunate accident the register was not running at this station; and the time results being noted by a watch are only approximate. Lieutenant Young reports: "Very shortly after the mine signal we felt quite a distinct tremor in the ground under us, and at the same time heard a low rumbling sound exactly similar to the first sounds heard after the explosion of a dynamite torpedo. The time between the mine signal and the tremor was about seven seconds; and the duration of the tremor as shown by the seismometer was about sixty-three seconds. The rumbling sensation lasted several seconds.

LIEUTENANT GRIFFIN AT WILLETS POINT—(distant 8.33 miles from the mine.)

These observations were perfectly successful. Lieutenant Griffin was provided with an instrument of the B type. He reports:

"The first evidence of the explosion was a sudden and very violent shaking of the mercury. The maximum effect *seemed* to be reached at once, and not gradually; but, as the first shake was so violent, it is *possible* that the maximum may not have been instantly attained, for a slight increase or diminution in the disturbance could not possibly have been perceived at that time.

"The motion of the mercury subsided quite rapidly to a regular vibration, which lasted for several seconds.

"The vibration as it appeared in the mercury may be shown by the following curve (Plate II).* This is designed to indicate that for some time it was impossible to distinguish any distinctive feature of the vibration, except the fact that it was violent. Then it gradually began to subside. This subsidence *increased* in rapidity up to a certain point and then *decreased*. After this the mercury settled down very gradually.

"I thought I heard the noise of the explosion simultaneously with the first vibration. It sounded something like a torpedo, but more muffled, and with more of a rumble, and, so to speak, roar to it. In this I may possibly have been mistaken, as none of the bystanders noticed it."

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* Omitted.

Measurements on the register paper showed that the first tremor was noted at 5.3 seconds after the explosion; that the violent agitation continued for 37.1 seconds, and that it continued perceptible for 35.2 seconds more; making a total period of 72.3 seconds during which the mercury was sensibly shaken.

LIEUTENANT KINGMAN, AT JAMAICA—(distant 9,333 miles from the mine.)

Everything at this station worked admirably. The instruments were placed in an old foundry, where the earth was very hard. Lieutenant Kingman reports: "A click of the armature informed me that the circuit had been closed at Hallet's Point. Following this came the vibration of the earth—sharp, strong, and unmistakable. The vibration was distinguishable for a period of about 30 seconds, decreasing in violence from the first, and growing less and less, until finally it could no longer be detected. If I were to represent the intensity of the shock by a curve, it would take a form like the right-hand figure on Plate II,* the ordinates being the intensity and the abscissas the time. There was a short period of intense vibration, which decreased rapidly at first, and then slowly and uniformly to zero.

"Accompanying the shock was a low rumbling sound of about three or four seconds' duration, which was distinctly heard by me, and also by a portion of the bystanders; there were some, however, who did not hear it. The sound and the shock came together, and the sound was loudest when the vibration was at its maximum. Though I listened intently for more than a minute after the explosion, no other sound of this character was heard; and I am satisfied that it must have been caused by the mine, for it was entirely similar to the sound of a torpedo when heard at a distance.

"In preparing to observe the shake I had focused my telescope on the reflected image of a horse-hair fastened to the glass cover of my artificial horizon. This image happened to be placed in the direction of wave propagation. On the arrival of the shock this image became distorted into an undulating line. The undulations seemed to start from the end towards Hallet's Point and run along the hair and then return, causing the image to present the appearance shown on the left-hand figure of Plate II.* It could be distinctly seen in each of its different positions."

The register paper showed that the interval between the explosion and the arrival of the tremor was 10.9 seconds; and that the latter continued 23.5 seconds—the instrument being of type A.

LIEUTENANT LEACH, AT SPRINGFIELD JUNCTION—(distant 12,769 miles from the mine.)

Here, too, the observations were everything which could be desired. The instrument was of the B type, which, it will be remembered, is doubly as sensitive as that used at Jamaica, and the same as that used at Willets Point. Lieutenant Leach reports:

"The soil in the vicinity of my station is a light sand, with a top soil not more than six inches in thickness.

The place selected for the instrument was in a lane where the travel had been sufficient to kill the grass, and firmly pack the top-soil, but not to cut through it.

I removed a little loose earth with a shovel, and then ground the artificial horizon into a firm contact with the solid earth.

As soon as the warning message was received, I put the line to ground east, and connected my local wires to the relay and battery in the telegraph office. I then went to the instrument, repeated the tests, and at three and a half minutes before the appointed time, set the register in motion.

At 2.51 p. m. by my watch a click, or rather a series of clicks, were heard on the register. This was the signal communicated by the firing of the mine, and its record on the paper was exactly like two "a's" of the Morse code. Five seconds after, another mark was registered on the paper, the cause of which must have been an accidental closing of the main line or of my key—which, I am unable to say. About thirteen (12.7) seconds after the firing signal the shock reached my station. As indicated by the seismometer, it was very violent, and seemed to attain its maximum instantaneously.

The amplitude of the vibration of the reflected image of the object wire was very much greater than the extent of my field, across which the rapidly vibrating wire images appeared but a thick haze.

For this reason I am unable to give a positive opinion as to the violence of the shock when at its greatest intensity, which would readily result were the greatest amplitude known.

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* Omitted.

But from the time the limits of vibration came within the field, I studied them as closely as the circumstances would permit.

The instant that I saw the wires re-enter the field is given by my 2d mark at 19 seconds after the firing signal, and the end of the vibration is indicated by my 3d mark at 31.67 seconds from the firing signal. During this interval my conception of the subsidence is represented by the following curve (Plate II).*

The full line represents the portion of the vibration which was in the field, and which I was able to observe. I have completed the curve according to the same law, and think it may be accepted as a close approximation to the greatest intensity, and subsequent decrease, up to the time at which I began to note the vibrations themselves.

The vibrations showed most unmistakably the peculiar wave oscillation which has been so frequently noticed in connection with shocks produced by exploding dynamite.

I think the distance of the instrument from the explosion was far within its limit for that shock, and believe it could not have failed to register the latter at two and a half or three times the distance.

The time at which the sound reached my station was not recorded, as the rain beating upon the tent prevented me from hearing it; but I had instructed my men, and had requested the bystanders, to listen sharply for it. A mean of their opinions would indicate that some sound certainly reached us; but the original wave had probably been completely dissipated, leaving only a superposition of echoes. At any rate, the result was a low rumbling sound which gradually increased to a maximum, and then as gradually died away. A large majority of those who were listening declared that they heard it.

The cause of the two letters, and of the subsequent mark (forming the letter T) to which Lieutenant Leach refers is curious. They are duplicated on the Jamaica record, and Lieutenant Young noticed their sound at his station. The paper at the firing station showed a continuous mark for the whole time occupied by the "A A." These facts prove that the tremor of the earth at the Astoria office, about 800 yards from the mine, was sufficiently violent to move the contact point of the relay; and the explosion thus actually sent a message consisting of the three letters A. A. T. down the line. The diagram (Plate II)* is a fac simile of the register records at the three stations, carefully plotted to a scale. The mark at the firing station, 1.1 seconds long, began at the closing of the circuit by the fall of the drop; it ceased when the circuit was broken by the withdrawal of the plug in the hands of the observer, which occurred when the jet apparently had reached about half its extreme height (125 feet). No better evidence of the instantaneous nature of the explosion can be desired.

LIEUTENANT BASS AT WEST POINT—DISTANT 52 MILES.

Lieutenant Bass had intended to observe with a magnifying power of twenty diameters, but the storm forced him to make use of a smaller glass having only a power of five.

He selected an admirable station among the hills, resting the mercury upon a ledge of solid rock, and observed intently for forty minutes in a pouring rain, thus establishing that no tremor observable with his instrument extended to that distance. This result, as already stated, confirms the accuracy of the empirical formula which indicates 33 miles as the limit. Probably a power of twenty would have detected a tremor.

ANALYSIS OF THE RESULTS.

The measurements upon the tremor caused by the blast at Hallet's Point, just described in detail, indicate a rate of movement far in excess of that reported by Mr. Mallet, and higher than might be anticipated from existing data upon the velocity of sound through solids. The most careful attention was, therefore, given to eliminating all possible causes of error. The distances were taken by Lieutenant Leach from the manuscript maps of the railroad surveys, drawn upon a large scale, and from the published coast survey maps, and may be depended upon as nearly correct. The time measurements, as already explained, are certainly inferior in precision to none that have ever been attempted in this kind of investigation. The following consolidated table, which exhibits the results in a form convenient for reference and comparison, must, therefore, be accepted as trustworthy, although in some respects surprising.

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*Omitted.

Station.	Distance from mine.	Type of instrument.	Tremor of earth—		Velocity of transmission.
	Miles.		Arrived in seconds.	Lasted for seconds.	Feet per second.
Fresh Pond Junction	5.184	A.	7.0?	63.0?	3873?
Willets Point	8.33	B.	5.3	72.3	8300
Jamaica	9.333	A.	10.9	23.5	4521
Springfield Junction	12.769	B.	12.7	19.0	5309

Certain observations upon the shocks produced by dynamite torpedoes, made before the blast at Hallet's Point was fired, also indicate a very high rate of transmission.

Thus, on August 18, Captain Livermore, of the Engineers, made observations upon the explosion of a 200-pound dynamite torpedo, planted 30 feet under a floating iron target in 42 feet water off Willets Point. His station was 5 miles distant, nearly in the prolongation of Little Neck Bay. He perceived the tremor distinctly with an instrument of the B type, reporting as follows: "The first indication of the explosion was given by the seismometer. The second was by the appearance of the jet of water to privates Newburg and Jones, the jet being at full height (110 feet) when first seen. The mercury continued to vibrate after these men had called 'time' for at least one second. The disturbance was equal to that from a stone, the size of a man's head, dropped from a height of 6 feet at a distance of 15 feet; but the duration was very different, having an increasing and decreasing phase, very perceptible."

The second of firing the torpedo was noted upon a chonometer with which Captain Livermore's watch was compared before and after the explosion; and the beginning of the tremor was noted on this watch. The difference proved to be about five seconds, which was much less than had been anticipated. Still, the fact of the tremor being felt before the jet had subsided, established the substantial accuracy of the record.

In like manner the time required for the tremor caused by a 100-pound dynamite torpedo to reach Fort Schuyler, across East River, was noted a few days later by Lieutenant Greene, of the Engineers. On this occasion the explosion was made to record itself with precision, through an insulated torpedo cable, in a manner similar to that used at Hallet's Point; and the result indicated 4,800 feet per second as the rate of transmission of the shock.

Notwithstanding all this evidence, I sought to find a satisfactory reason to account for the extraordinary discrepancy between my results and those of Mr. Mallet, whose reputation in earthquake investigations, both as an observer and as a theorist, is so well established. He reported the velocity of transmission of artificial impulses to be in sand, 825 feet; in discontinuous and much shattered granite, 1,306 feet; and in more solid granite, 1,665 feet per second. Also, from observations upon the explosion of large mines of powder in the quarries at Holyhead, he states: "The mean lowest rate of wave transit in these rocks through measured ranges of from 5,038 to 6,582 feet was 1,089 feet per second; and the mean highest, 1,352 feet per second; and the general mean 1,320 feet per second." As all my data referred to explosions of dynamite, and his to gunpowder, I finally determined to try one experiment with the latter.

Accordingly on October 10, I fired a charge of 70 pounds of mortar powder in a wooden torpedo case, 5 feet below the surface in 13 feet of water. Captain Miller and Lieutenant Kingman, of the Engineers, were stationed at a distance of about a mile, the former with a telescope and key to close a register circuit when he saw the flash of a gun, to be fired by the same current which exploded the torpedo, and the latter with a seismometer of type A and a key to close the circuit when the mercury became agitated. The observation was perfectly successful, the time of transmission being 5.8 seconds for 7,200 feet, indicating a velocity of 1,240 feet per second. Hence, since 2,100 feet of the route lay through water, this gunpowder explosion accorded fairly with the gunpowder results obtained by Mr. Mallet.

At first sight these facts would seem to indicate that the shock given by an explosion of dynamite is transmitted much faster than one from an explosion of gunpowder. Although the character of the impulse is widely different in the two cases, such a proposition certainly cannot be accepted without further evidence, although it is not novel. In a note to Silliman's Physics, it is stated: "Rev. E. S. Earnshaw, of Sheffield, England,* lately brings good evidence, both mathematical and physical, to show that the accepted views stated in § 343 are correct only for sounds having no very great difference of intensity. The velocity of sounds of all kinds is a certain function depending upon the rapidity and length of vibration. In the case of violent thunder, the numerical value of this function becomes much greater than for ordinary sounds. These, and other remarkable conclusions, are sustained by mathematical reasoning. The author of the memoir also cites evidence to show that the crash of violent thunder claps has been often heard almost simultaneously with the flash of lightning, although the stroke fell several miles distant." Captain Handbury, of the Engineers, also informs me that on one occasion when approaching a battery at drill, about a third of a mile distant, he heard the explosion of the gun and distinctly after it, probably as much as a second, the command to fire. This occurred at West Point, N. Y. A similar fact was noted on Perry's second voyage.

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*London, Edinburgh, and Dublin Phil. Mag. from June, July, September, 1860.

Nevertheless, since these observations have revealed the fact that the tremor consists of a long-continued succession of earth waves lasting for many seconds, I am more inclined to accept a suggestion of Lieutenant Kingman, who noticed at the gunpowder explosion that the movement was very slight, and only continued for an instant, showing that his seismometer was near the limit of its range. He suggests that if there be a gradual increase followed by a gradual decrease in the amplitude of the earth waves, a delicate seismometer will detect the arrival sooner than one less sensitive. In other words, the vibrations will begin sooner, as well as last longer, for such an instrument. This would apparently reduce the time of transit, and thus increase the measured velocity, when instruments of high power are employed, as at Willets Point and Springfield Junction.

In fine, the extraordinary duration of the vibrations produced by these dynamite explosions, and especially by that of the great blast as noted at Willets Point, to which the shock had both a water and a land route, is certainly a novel feature in artificial impulses; and, in connection with the hardly less estraordinary velocity of the general wave front, well merits attention. The latter is the more surprising, because Long Island geologically belongs to the drift formation, and is, of course, far from homogeneous in structure. It is, therefore, proposed to continue the investigation next spring, taking advantage of certain torpedo explosions which will be required in prosecuting the course of experiment now in progress at the School of Submarine Mining at Willets Point.

B.—ON THE VELOCITY OF TRANSMISSION OF EARTH WAVES.*

By Bvt. Brig. Gen. H. L. ABBOT, *major, Corps of Engineers.*

Believing at the date of my first paper that the data secured at the Hallets Point explosion demonstrated the necessity for more exact and comprehensive knowledge of the subject, I have during the past season taken advantage of the facilities offered by large subaqueous explosions at the School of Submarine Mining at Willets Point to continue the investigation, and on October 23, 1877, I read a second paper before the National Academy of Sciences, giving the results thus obtained. As only a brief abstract of this paper has appeared in print, I propose now to give a summary of the conclusions suggested by the whole series of experiments.

Limited space forbids any detailed explanation here of the method adopted for measuring the time of transmission of the shocks; especially as this is fully given in my printed paper, together with the notes of the observers in full. Suffice it to say that the instant of explosion and the time of arrival of the tremors were electrically recorded on the same moving paper with extreme precision. The following table exhibits the data: * * *

No. of observations.	Date.	Observer.	Cause of shock.	Distance to station.	Type of seismometer.	Tremor of mercury.		Velocity of transmission.
						Arrived in.	Lasted for.	
				Miles.		*Secs.*	*Secs.*	*Feet per sec.*
1	Aug. 18, 1876	Capt. Livermore	200 lbs. dynamite..	5 ±	B.	5 ±	....	5,280 ±
2	Sept. 24, 1876	Lieut. Young ..	Hallet's Point ex..	5.134	A.	7 ±	63 ±	3,873 ±
3	Sept. 24, 1876	Lieut. Griffin ...	....do	8.330	B.	5.3	72.3	8,300
4	Sept. 24, 1876	Lieut. Kingman.	....do	9.333	A.	10.9	23.5	4,521
5	Sept. 24, 1876	Lieut. Leach ...	do	12.769	B.	12.7	19.0	5,300
6	Oct. 10, 1876	Lieut. Kingman.	70 pounds powder..	1.360	A.	5.8	Inst.	1,240
7	Sept. 6, 1877	... do	400 lbs. dynamite ..	1.169	A.	1.8	7.8	3,428
8	Sept. 6, 1877	Lieut. Leach ...	... do	1.169	B.	0.7	17.8	8,614
9	Sept. 12, 1877	Lieut. Griffin ...	200 lbs. dynamite ..	1.340	A.	1.05	8.8	6,730
10	Sept. 12, 1877	Lieut. Leach....	do	1.340	B.	0.81	17.1	8,730
11	Sept. 12, 1877	Lieut. Griffin ...	70 pounds powder.	1.340	A.	1.27	4.8	5,550
12	Sept. 12, 1877	Lieut. Leach....	....do	1.340	B.	0.84	15.1	8,415

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*Extracts from an article in the American Journal of Science and Arts, Vol. XV, March, 1878.

Mr. Mallet's results were reported many years ago to the Royal Society, and unquestionably are to be accepted as exhibiting the velocities due to his initial shocks and given by the method which he employed. * * * The following are his figures:

Velocity, in feet, per second in sand	825
Velocity, in feet, per second in discontinuous and much shattered granite	1,306
Velocity, in feet, per second in more solid granite	1,665
Velocity, in feet, per second in quarries at Holyhead (mean)	1,320

The extraordinary differences between these rates and those measured at the Hallet's Point explosion, and the apparent discrepancies of the latter among themselves, led me to so plan the new observations as to throw light upon two points: 1st. Does a telescope of high power detect a tremor in the mercury in advance of the one first revealed by a lower power? 2d. Is there a difference in the rate of transmission of the shocks due to differences in the intensity of th einitial explosion?

The method adopted was to station two observers near each other at a carefully selected inland position, each observing a mercury seismometer, and holding in his hand the key of an accurate Morse register to record the instant of arrival and the duration of the tremor. These seismometers were the same instruments used at the Hallet's Point explosion. They differed from each other only in the optical power of the telescope, that designated A in the table having a magnifying power of 6, and that marked B of 12.

A fuze in the electrical circuit which fired the torpedo was bedded in the cartridge of a field-gun directed toward the observers, and as a very powerful battery was used, the two explosions were absolutely simultaneous. A third observer, holding in his hand a key which closed the circuit of both registers, observed the muzzle of this gun with a good telescope, and recorded the flash electrically with precision. The observers were all officers of the Corps of Engineers accustomed to delicate observations. The distance traversed by the shock was measured by triangulation.

The observations of September 6 and September 12, 1877, marked 7 to 12, and sufficiently explained in the foregoing table, answered the query relative to optical power decisively in the affirmative, and, as may be seen from the table, the earlier observations singly and collectively suggest the same conclusion. The mean velocity given by the six observations with type A is 4,225 feet per second, while that given by the same number with type B is 7,475 feet per second. There can, therefore, be no doubt that the first tremor of the mercury is of too feeble intensity to be detected with a magnifying power of 6. Hence, as the first tremor determines the true rate of transmission of the shock, the rejection of all the observations made with type A follows as a matter of course. They are valuable as exhibiting the rate of advance of waves having a certain intensity, but they do not reveal the velocity of the leading tremor. Indeed, it is not impossible that a power above 12 might have detected a still earlier tremor, or, in other words, have indicated velocities of transmission exceeding those in the table.

These conclusions are so novel and important that certain additional evidence will be given, furnished by the notes of the observers recorded at the time and without consultation.

Lieutenant Leach, using a power of 12, recorded of the second observation of September 12 (No. 12), "The gunpowder wave was peculiar, in having a much more gradual increase than has been observed in dynamite shocks. I should say it was at least two seconds in attaining a maximum, whereas the dynamite usually reaches its maximum in a very small fraction of a second."

Lieutenant Griffin, who used a power of 6, recorded of the same shock (No. 11), "The gunpowder disturbance remained constant for a perceptible interval, instead of immediately decreasing, as is the case with dynamite."

It will be noticed that the shock of October 10, 1876 (No. 6), was caused by the explosion of 70 pounds of gunpowder—the same charge which was fired on September 12, 1877, and to which these records refer—but that the duration of the tremor was much less. The reason is that the initial earth waves were far more violent in the latter case, when the torpedo lay on the bottom in 30 feet of water, than in the former, when the charge was only submerged 5 feet in water 13 feet deep, and thus expended much of its energy in throwing a huge jet of water 330 feet into the air.

Thus it will be seen that these records, and the velocities observed on the two days, all tend to confirm the idea that a slow-burning explosive, like gunpowder, generates a series of gradually increasing tremors which, at a distance of a mile, are at first quite invisible with the less sensitive seismometer; and are only detected by it when near their maximum intensity. If Lieutenant Leach's estimate of time for the arrival of the maximum wave be accepted, we have, therefore, for the first mile:

Deep torpedo (70 pounds.)	Power of 12 gives	8,415 feet per second.
	Power of 6 gives	5,559 feet per second.
	Estimated minimum power gives	2,489 feet per second.
Shallow torpedo (70 pounds)	Actual minimum power gives	1,240 feet per second.

Without wishing to attach undue weight to these records, they appear to me to suggest a possible explanation of the discrepancies between the results obtained by Mr. Mallet and myself. * * *

As to the second query, Whether the rate varies with the intensity of the initial shock the data, although less decisive, certainly suggests an affirmative answer. The evidence afforded by No. 6 and No. 11 has been already pointed out. For a power of 12 the table shows that for the first mile:

400 pounds of dynamite give 8,814 feet per second.
200 pounds of dynamite give 8,730 feet per second.
70 pounds of powder (deep), 8,415 feet per second.

If it be admitted also that the velocity of the wave diminishes with its advance, all the data become accordant. Thus:

200 pounds of dynamite give for 1 mile, 8,730 feet per second.
200 pounds of dynamite give for 5 miles, 5,280 feet per second.
50,000 pounds of dynamite give for 8 miles, 8,300 feet per second.
50,000 pounds of dynamite give for 13¼ miles, 5,300 feet per second.

In fine, I believe that the following general conclusions are suggested by these measurements: (1) A high magnifying power of telescope is essential in seismometric observations. (2) The more violent the initial shock the higher is the velocity of transmission. (3) This velocity diminishes as the general wave advances. (4) The movements of the earth's crust are complex, consisting of many short waves, first increasing and then decreasing in amplitude; and, with a detonating explosive, the interval between the first wave and the maximum wave, at any station, is shorter than with a slow-burning explosive.

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In fine, my own opinion is that in this, as in all physical investigations, the more thoroughly the ground is covered the greater will be the number of important facts developed; and that complex rather than simple phenomena should be expected. It is quite impossible to ascribe the discrepancy between Mr. Mallet's results and those here described to inaccuracy of observation. Differences in the material traversed by the waves and in the method of observing may possibly explain them.

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C.—SEISMOGRAPHIC OBSERVATIONS AT ASTORIA.

[Report of Capt. J. G. D. Knight, Corps of Engineers.]

I have to report the following duties performed by me in connection with seismographic observations of the explosion at Flood Rock, October 10, 1885.

In compliance with S. O. No. 151, current series, from Headquarters Corps of Engineers, U. S. A., on September 29, 1885, I examined and reported upon the suitability as observation stations of Patchogue, Babylon, and Springfield, on the Long Island Railway.

I prepared four sets of telescopes used by the observation parties at Patchogue, Bay Shore, Pearsall's and the astronomical observatory at Willets Point. The arrangement was in principle that used for observing at Springfield Junction, L. I., the effect of the explosion at Hallett's Point, September 24, 1876, consisting of two telescopes, the eye-piece of one removed and the image of its cross-hairs reflected by an artificial horizon through the other telescope to the observer. The magnifying powers of the observing telescopes were respectively nineteen, eighteen, fourteen and fourteen, as determined to the nearest unit by observing with the unaided eye the number of divisions on a stadia covered by one or more divisions of the same as seen with the other eye assisted by the telescope in question.

I prepared crude seismographs of three forms, which were set up in the vicinity of Flood Rock: (1) after the design of Mr. Robert Mallet, white pine cylinders all 4 inches in length, 1.5, 1.0, 0.75, 0.50, and 0.37 inches in diameter. The latter were blown down and hence not used, and difficulty was experienced in one case in trying to make the next smaller size stand. These cylinders rested on wooden strips 22 inches long, 1½ inches high and 1½ inches wide, partially imbedded in sand to prevent movement of cylinders after having been overturned. It would have been better had each cylinder rested on a shorter cylinder of equal diameter with its own, the shorter cylinder securely fastened to the strip, and the sand brought up to the level of the top of the shorter cylinder to prevent movement of cylinders also, in cases where they fell on the strips: (2) flat blocks hollowed out in the middle to hold mercury, with radial grooves falling as they left the bowl and ending in cylindrical holes, the latter and the inclination of the grooves to prevent the return to the central reservoir of mercury once ejected therefrom: (3) iron wires 21 inches long and one-tenth of an inch in diameter, pointed at top, fastened in blocks at the bottom, each wire weighted with two leaden bullets one-half inch in diameter, touching one another 1 inch from top of wire. It was proposed to have the points mark any motion communicated to them in paraffine; but the latter having been found too hard, a mixture of lard and tallow was countersunk in a block supported above the wire of one seismograph, and, owing to an accident, lard alone above the wire of the other. A score of ⅛ inch was registered on the first, set up on the Hallet's Point light-tower; and one of about ⅜ inch on the second, at station VI (see Plate III); but when taking the instruments to pieces for repacking I failed to note the azimuth of the scores.

On Plate III is marked the locations at which these three forms of seismographs were set up. At station I on the light-tower, 256 feet high, the superintendent in charge kindly placed one of each form. The others of type II, two in number, were set up at points "M;" and one of type III, at the point "W." At other stations only type I was used. Station VII was used at the last moment, in the hope of being able with impromptu means to approximately determine the height to which the water was raised by the explosion. The greatest height observed was estimated to be 286 feet.

All stations other than numbers I and VII were on a filling of from 3 to 6 feet of earth over marsh-sod.

The results obtained by the seismographs of types I and II are shown on Plate II. On this is represented each instrument as it would be if revolved in a horizontal plane until the plotted magnetic bearings of Flood Rock flagstaff, as determined at each station, coincide: distances given are from this staff. When multiplied by ten grains the figures on the mercury seismographs will give the amount of mercury found in the corresponding holes. Cylinders marked with a cross remained standing after the explosion. On page 612, vol. VII, Encyclopædia Britannica, 9th edition, is given Professor Haughton's approximate formula for determining, with the aid of the seismograph of type I, the velocity of the earth wave:

$$v^2 = \frac{15b^2 + 16a^2}{12a^2} g \sqrt{a^2 + b^2}(1 - \cos \theta)$$

where a is the altitude and b the diameter of the base of the cylinder, and θ the angle formed by the side and a line drawn through the center of gravity to the extremity of the base. Applying this to the various cylinders used, it is found that velocities of 3.6, 2.4, 1.8, and 1.2 feet per second are necessary to overturn the cylinders of the four larger sizes.

I fail to see what inference can be drawn from the results, as plotted; cylinders of larger sizes fell, while smaller ones remained standing; and the directions in which those which fell rested after so doing vary, though the motion of the light-tower doubtless rendered registers of seismographs thereon discordant with those of others on terra firma. The two mercury seismographs not on the tower harmonize to some extent, in showing a flow of mercury in directions at right angles to the direction of Flood Rock from their stations.

D.—DETERMINATION OF THE INSTANT OF EXPLOSION.

[Report of Capt. Thomas N. Bailey, Corps of Engineers.]

I have the honor to submit the following report concerning time determinations, in connection with seismoscopic observations on the occasion of the recent explosion at Flood Rock.

As all the observing stations under your charge, except Willets Point, were connected by telegraph with Astoria, the measurement of the interval between the time of explosion and the time of arrival of the shock at the former stations required simply the difference of readings recorded by special Morse registers at each station. At Willets Point it was necessary to determine this interval by comparisons of chronometers; one being transported to and from Astoria and compared, before and after the explosion, with another chronometer at Willets Point. The chronometer used at Willets Point was Lukens No. 141, the standard of the observatory. The astronomical work of the season just terminating shows that its rate has been reasonably uniform for five months.

The chronometer transported and used at Astoria was Negus No. 1,499, which had been selected from others on account of its uniformity of rate shown by daily comparisons with the Lukens since September 25, 1885. Both of these were sidereal chronometers supplied with the Negus break-circuit attachment.

Lieutenants Chittenden and Taylor, Corps of Engineers, determined the error of the Lukens by astronomical observations taken on the night preceding and on the night following the explosion. The Buff and Berger transit (focal length 39 inches, clear aperture 3 inches) and the Hipp chronoraph were used.

Time results.

	October 9.	October 10.
Number of time stars	6	7
Value of *c*	+1.55	+1.54
Value of *a*	—0.33	—0.19
Lukens slow, seconds	60.38	61.22
At sidereal time, hours	20.76	20.61

The comparisons of Lukens with Negus were made by ear, direct, and also through a third chronometer as a check.

The following were the last comparison before and the first one after the explosion:

	Sidereal time
October 9, Negus fast of Lukens, 28.2 seconds at	17h. 43m.
October 10, Negus fast of Lukens, 31.5 seconds at	15h. 45m.

The interval between the explosion and the last comparison was about three hours.

In transporting the Negus, the usual precautions were taken to avoid as far as practicable a disturbance of rate. Comparisons before and subsequent to the explosion show that its rate was not sensibly affected by its transportation.

The key record of explosion was at 12h. 35m. 54.8s. Negus chronometer time. From the foregoing data we have the following computed results:

Rate of Lukens, October 9–10; 0.039 second per hour, losing.

Rate of Negus on Lukens, October 9–10; 0.150 second per hour, gaining

Lukens time of explosion, $12^h\ 35^m\ 23.8^s$, October 10.

Mean solar time of explosion, 75th meridian, $11^h.\ 13^m.\ 50.2^s$, October 10.

In this last result, the longitude of Willets Point enters with full weight; that used was $4^h.\ 55^m.\ 07.66^s$. west from Greenwich.

About one hour after the explosion Professor Waldo, of Yale, kindly furnished me with the following comparisons taken by him between his watch and our Negus No. 1499.

The watch indicated 75th meridian mean time, and the Professor writes: "I assume that my watch's error was not over one second."

Negus 1499.		Watch.
$13^h\ 48^m\ 46.5^s.$	=	$12\ 26^m\ 30.0^s.$
$13^h\ 49^m\ 16.5^s.$	=	$12\ 27^m\ 00.0^s.$

From the above comparisons may be deduced 11h. 13m. 503^s as the 75th meridian mean time of explosion; thus giving an interesting and independent check on the result previously deduced from our own direct observations.

E.—PHOTOGRAPHS TAKEN AT ASTORIA.

[Report of First Lieut. J. L. Lusk, Corps of Engineers.]

I have the honor to submit the following report upon the work of the photographic laboratory in connection with the explosion of Flood Rock on October 10, 1885.

At the time orders were received to prepare to take views of the explosion there were in the laboratory only two cameras suitable for that purpose. Two others were kindly loaned; one by E. & H. T. Anthony & Co., the other by Mr. Jacob Wieners, jr., of College Point, Long Island.

Three of the available cameras were fitted with light drop shutters, each supported by a thread attached to a fuze. The fuze was so placed in an electrical circuit that the closing of a key would explode it and thus break the thread and drop the shutter. The fourth camera was fitted with a Prosch shutter, arranged to expose the plate on the pulling of a delicate trigger.

On reaching Astoria on the morning of the explosion a reconnoissance was made to determine whether or not a better point of view could be found than the one provisionally adopted: *i. e.*, the firing point. The latter presented an unobstructed view of the area to be photographed, and allowed the use of short and easily protected electrical circuits. Its sole disadvantage lay in its nearness to Flood Rock, which, it was known, would render it impossible to catch a view of both ends of the disturbed water on one plate. The only other practicable position at Astoria was on a roof, of the use of which I had the refusal, where the vibration due to the explosion would probably have interfered with the action of the shutters. The firing point was accordingly adopted; and in order to best show the progress of the explosion, the cameras were so placed and adjusted that each plate would show the northeast end of the disturbed area. The four instruments were placed in line about 1,130 feet from the tall hoisting-frame on Flood Rock, and each was focused on the frame.

Numbering the cameras in order from left to right, the fuze of No. 1 was so connected with the firing circuit of the mine as to be exploded by the same key and the same action of closing, a short delay being effected (1) by causing the moving part of the key to traverse a slightly greater arc in closing the camera circuit than in completing that to the mine; and (2) by the interposition of a relay. Nos. 2 and 3 were arranged to be fired at will by an independent key, the time of making and breaking each circuit being recorded on a chronograph register, as was the case with No. 1. No. 4 was not connected with the chronograph. Nos. 1, 3, and 4 gave satisfactory views of the explosion; while the plate in No. 2 was not exposed, due to some irregularity in the explosion of the fuze, which blew the thread violently forward and jammed it in a crevice of the shutter-case.

Exposure No. 1, made at about 0.2 seconds after the closing of the mine circuit, shows that the camera itself was steady at that instant, but that the earth wave had reached a point not more than 175 feet distant. Exposure No. 3, at 0.6 seconds after closing the mine circuit, shows that the camera was steady and that the more violent portion of the earth wave had passed. Exposure No. 4 shows the hoisting-frame lifted about 30 feet into the air, and the tallest jet with a height of 160 feet. There was a marked increase in the height of the jets after the exposure of No. 4, the last available plate.

As soon as practicable after the explosion the absolute lengths of the exposures were measured by Professor Pickering's method of photographing a freely falling silvered ball. The results are:

For No. 1, 0.034 seconds.
For No. 3, 0.05 seconds.
For No. 4, 0.02 seconds.

A comparison of the views taken with one obtained by Lieut. John Millis, Corps of Engineers, from the top of the electric-light tower at Hell Gate, indicates that most of the tall jets rose in a fringe closely surrounding the unsubmerged part of the rock, and extending out not farther than the 12-foot contour, as shown on the map contained in the report of the Chief of Engineers for 1882.

It is a matter of regret that the stock of cameras fitted for work of the kind under consideration was so limited as to prevent the securing of at least six views of the water in motion.

Other views were taken showing the appearance of Flood Rock before and after the mine was fired; the best of these, with the three views of the explosion, constitute a set of five negatives, prints from which have been submitted to the Battalion commander.

E 6.

IMPROVEMENT OF NEWTOWN CREEK, NEW YORK.

Newtown Creek is a sluggish stream, about 4 miles long, running through the eastern part of Brooklyn and emptying into the East River opposite Thirty-fourth street, New York.

In 1857 it had a depth of about 17 feet, which had decreased in 1880 to about 12½ feet at low water, from its mouth up to the Vernon Avenue Bridge, a distance of 1,100 feet, its width for this distance being about 240 feet. Thence it gradually decreased in width and depth, until at the head of navigation, where Metropolitan avenue crosses it, there was a low-water depth of about 4 feet and a width of about 100 feet.

A survey of this creek with a view to its improvement was ordered by act of Congress approved March 3, 1879, and was made under General Newton's direction, and reported upon by him January 31, 1880. The project which he presented provided for dredging a channel from the mouth of the creek to Vernon Avenue Bridge, 200 feet wide and from 18 to 21 feet deep at low water, requiring the removal of 145,000 cubic yards of material chiefly mud, the cost of which was estimated at $36,250.

Work under this project was begun in 1880, but by reason of inincreased cost of dredging, the estimated cost was increased to $44,050.

Under act of Congress passed August 2, 1882, another survey was made under direction of Major Gillespie, whose report is dated December 26, 1883. His project provided for carrying the improvement from the Vernon Avenue Bridge up to the head of navigation in both branches of the creek. The estimated cost for executing this project was as follows:

To excavate a channel 18 feet deep and 175 feet wide, from Vernon Avenue Bridge to the Central Oil Works, 143,500 cubic yards excavation, at 30 cents	$43,050
Thence, 15 feet deep and from 125 to 150 feet wide, to Queens County Oil Works, 101,600 cubic yards excavation, at 35 cents	35,560
Thence, 12 feet deep and from 125 to 150 feet wide, to Nichols Chemical Works, 52,600 cubic yards excavation, at 40 cents	21,040
Thence, 10 feet deep and from 100 to 125 feet wide, to the heads of navigation on both branches, 231,600 cubic yards excavation, at 40 cents	92,640
Contingencies	19,229
	211,519
To which must be added the revised estimate for work below Vernon Avenue Bridge, before given	44,050
Total estimated cost of improving Newtown Creek	255,569

Up to June 30, 1886, $45,000 of this amount had been appropriated; and, with it, the channel below the Vernon Avenue Bridge had been given a depth of 18 feet, with a width varying from 75 feet at the bridge to 150 feet at the mouth of the creek; and channels 10 feet deep and from 50 to 200 feet in width had been dredged from Covert's Dock up to the bridge at Metropolitan avenue and Grand street on the west branch, and to Grand Street Bridge on the east branch, the distances being about 3,000 and 1,000 feet, respectively.

The act of Congress approved August 5, 1886, appropriated $37,500 for the improvement, but directed that $9,375 should be expended on the west branch between Maspeth avenue (Covert's Dock) and what is called the Dual Bridge, at Grand street and Metropolitan avenue; $9,375 on the main branch between easterly Grand Street Bridge and Metropolitan avenue; and the balance on the lower end from Maspeth avenue to the mouth.

The two former amounts will be applied as directed, and the remainder of this appropriation, as well as the remainder of the appropriation of August 5, 1884, will be applied to widening the channel below Vernon Avenue Bridge, to widening and straightening the approaches to the Penny Bridge, where very awkward bends occur; and, finally, to beginning the improvement up stream from Vernon Avenue Bridge.

The rise and fall of tide in the creek is about 4.5 feet, but the bed of the creek has no natural slope. It is the receptacle for all the refuse from the sewers, factories, refineries, and slaughter houses of the east of Brooklyn. Constant deposits are, therefore, forming in it, especially at the upper end, from these causes and from the caving-in of the unprotected banks, which consist of marsh mud.

To remedy this difficulty annual dredging will be required until the banks are protected by bulkheads throughout their whole length.

The commerce of the creek is so large that this improvement should be pushed at least 3 miles up as soon as possible; and $100,000 can be well applied there in the next fiscal year.

No statement of commerce has been received for this fiscal year; from the bridge tender's statement, the daily average of times the draw is opened is about the same number as last year, 130.

Many of the ships going above the bridge could load to a draught of from 20 to 23 feet; but they can take on only a part of their load (say to 16 feet draught) in the creek, and then finish it at the wharves in deeper water in the East River.

AMOUNTS APPROPRIATED.

Date.	Application.	Amount.
June 14, 1880	Dredging below Vernon Avenue Bridge	$10,000
Aug. 2, 1882	do	15,000
July 5, 1884	Part applied above Vernon Avenue Bridge	20,000
Aug. 5, 1886		37,500
	Total	82,500

Amount expended to end of year ending June 30, 1886, $38,690.47.

COMMERCIAL STATISTICS.

No statement of the commerce of Newtown Creek has been received for the fiscal year ending June 30, 1886, but a complete statement may be found in the Annual Report of the Chief of Engineers for 1884, part I, Page 727.

This work is in the collection district of New York. Nearest port of entry, New York City; nearest light-house, Blackwell's Island Light; nearest fort, Fort Columbus.

Amount of revenue collected at the port of New York during the fiscal year ending June 30, 1886, $132,536,402.02.

ORIGINAL ESTIMATE.

For dredging from mouth of creek to head of navigation	$236,340
Contingencies	19,229
Total	255,569

Money statement.

July 1, 1885, amount available	$7,419 96
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,110 43
July 1, 1886, amount available	6,309 53
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	43 809 53
Amount (estimated) required for completion of existing project	173,069 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 7.

IMPROVEMENT OF BUTTERMILK CHANNEL, NEW YORK.

Governor's Island lies opposite the Battery at New York, in the mouth of the East River, at its junction with the harbor. The channel on the north side of the island is the widest and deepest, and may be called the main channel. The channel between Governor's Island and the city of Brooklyn is known as Buttermilk Channel.

This channel is obstructed by three shoals.

1. A mid-channel shoal, lying above and northeasterly of Governor's Island, which originally had a least depth of 9½ feet over it at mean low water.

2. A shoal putting out from Red Hook Point, and extending up the eastern side of the channel to the entrance of the Atlantic Basin, with a least depth of about 5 feet over it at mean low water.

3. A shoal putting out from the southern side of Governor's Island towards the Red Hook Shoal, which is partly dry at mean low water.

A crooked channel about 700 feet wide and 30 feet deep lies between the two latter shoals.

Between the first-mentioned shoal and Governor's Island to the west of it is a narrow channel with 26 feet water in it, and between this shoal and Brooklyn, east of it, there was originally a narrow channel of the same depth, widened now to about 900 feet.

The line of docks and wharves from the Brooklyn Bridge down to the mouth of the Atlantic Basin, on the Brooklyn side, is one of the most important in New York Harbor; and this part of the river, extending from the Brooklyn Bridge to Governor's Island, is regarded by pilots and masters of vessels as the most difficult place in New York waters to carry a vessel through safely, not excepting Hell Gate in its present condition, on account of the enormous traffic passing not only up and down, but across the stream.

Tows, tugs, small steamers, and small craft generally, in passing up and down this part of the East River, hug the New York side, forcing the larger class of Sound steamers, ocean steamers, and sea-going ships in tow of tugs, to keep over towards the shoal at the upper point of Governor's Island; and if, as is often the case, these large vessels are obliged to stop in order to avoid collision with ferry-boats, sloops, and canal-boat tows, they are liable to drift upon this shoal.

Based upon the representation of shipping merchants whose business lay along the Brooklyn wharves lying between Wall Street Ferry and the Atlantic Basin, a survey of this shoal was ordered in 1872, and a project for its improvement was adopted in 1880.

This provided for the removal, to a depth of 26 feet at mean low water, of such parts of the eastern side of the shoal as came within 850 feet of the Brooklyn wharves.

A brief history of this improvement, with a sketch, will be found in the Annual Report of the Chief of Engineers for 1885, Part I, page 670.

The estimated cost of this improvement was $140,000, which provided for the removal of 570,000 cubic yards of material, at the rate of 23 cents per cubic yard, with 12 per cent. for contingencies.

The first appropriation for this work was made June 14, 1880, since which time other appropriations have been made and the work has been carried on up to November 3, 1884, during which time 466,276 cubic yards of material have been removed; but owing to the distance from the place of excavation to the place where the dredged material had to be dumped, which is outside of Sandy Hook, a distance of about 20 miles, the prices bid for the work have been more than 50 per cent. greater than had been anticipated, and the estimated cost of the improvement had to be increased, therefore, to $210,000, of which $190,000 had been appropriated up to June 30, 1886.

With this amount the channel has been deepened certainly to 24 feet, and it is believed to a full depth of 26 feet, at mean low water, though this has not yet been determined by actual survey over the proposed width of 850 feet, which includes the original crest of the shoal, so that outside of the lines of dredging there should be no less depth than 17 feet at mean low water. But the last survey, made in June, 1884, showed that a material shoaling had taken place on parts of the undredged portions of the shoal since the first work was done, amounting at that time to about 37,000 cubic yards which reduced the depths on the shoal outside of the line of dredging to 13 feet at mean low water, instead of 17, as it should have been.

This shoaling is probably due to the fact that the city authorities have a scow anchored on the shoal, to which tugs, steam-lighters, and small steamers transfer their ashes, and during this transfer a part of the ashes falls overboard between the steamboat and the scow.

The recommendation was made in my last annual report that the width of this channel should be increased from 850 to 1,150 feet, unless, indeed, it was decided to remove the whole shoal to a depth of 26 feet; and $50,000 was recommended for beginning the further widening of the channel.

When the last detailed survey of this shoal was made in June, 1884, it appeared that the excavation of about 336,057 cubic yards of material would be required for the removal of the whole shoal, of which 30,097 cubic yards have since been taken out under a contract made in 1884. This would leave 305,960 cubic yards yet to be taken out, which at 50 cents per cubic yard would cost about $150,000 without contingencies.

In view, however, of the shoaling which has occurred here during the progress of the work, judging from the experiences from 1880 to 1884, it is advisable to increase this estimate by $20,000, making a total of $170,000 required for the removal of the whole shoal.

The large and increasing traffic of this part of the river certainly warrants the removal of the whole shoal.

The appropriation of $56,250 made by act of Congress approved August 5, 1886, will be applied to the removal of the shoal by dredging, and $50,000 is asked for continuing the improvement next year.

A statement of the commerce of Buttermilk Channel may be found in the Annual Report of the Chief of Engineers for 1884, Part I, page 703, but it does not give any idea of the passing traffic of this channel.

Appropriations for the improvement of Buttermilk Channel, New York, have been made as follows:

Date.	Application.	Amount.
June 14, 1880	Dredging	$60,000 00
Mar. 3, 1881	do	60,000 00
Aug. 2, 1882	do	60,000 00
July 5, 1884	do	10,000 00
Aug. 5, 1886	do	56,250 00
	Total	246,250 00
	Amount expended	189,775 08

This work is in the collection district of New York. The nearest port of entry is New York City, and the nearest work of defense, Fort Columbus, New York Harbor.

Amount of revenue collected at the port of New York during the fiscal year ending June 30, 1886, $132,536,402.02.

Money statement.

July 1, 1885, amount available	$324 97
July 1, 1886, amount available	324 97
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	56,574 97
Amount (estimated) required for completion of existing project	113,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 8.

IMPROVEMENT OF GOWANUS BAY, NEW YORK.

Gowanus Bay, which is a part of New York Harbor, lies at the mouth of Gowanus Creek, on the southwestern side of the city of Brooklyn. The depth of water in the channel of Gowanus Bay and Creek was originally only from 7 to 12 feet at mean low water, which was wholly insufficient for the wants of vessels employed in the commerce of the district. A survey of it was made in 1880, and a project for its improvement was submitted in January, 1881.

This was, briefly, to dredge a channel between the pier lines established by the commissioners appointed by the State of New York in 1875, from the bay up the creek to Hamilton Avenue Bridge, 18 feet deep at mean low water, with a width of 200 feet, except for the upper few hundred feet, near the bridge, where the width was to be gradually reduced from 200 feet to 100 feet. The total length of the proposed channel was about 9,000 feet. The estimate for the improvement was:

530,000 cubic yards of dredging, at 30 cents per cubic yard	$159,000 00
Contingencies	23,850 00
Total	182,850 00

This proposed channel, however, did not coincide with the natural channel at the mouth of the creek, for the pier line established by the commission crossed the natural channel at that point, and the land under water inside of it had become private property.

The owners of this property, Messrs. Beard & Robinson, were anxious, nevertheless, to have the natural channel improved, instead of having the new one formed outside of the established pier line; but as this could not be done unless they surrendered their right to build out to the pier line, they signed a paper relinquishing their right to build out piers which should interfere with the channel so long as that channel should exist; and the Maritime Association of New York at the same time petitioned that the old channel should be kept open. As improving this channel alone would not, however, help the wharves on the opposite or southerly side of the creek, General Newton recommended that the natural channel should be dredged from the Hamilton Avenue Bridge down to the southwest corner of the Erie Basin; and that from that point two channels should be dredged, one running northerly along the west side of the Erie Basin to deep water near Red Hook; and the other, running southerly along the wharves on the south side of the bay, towards Bay Ridge.

Both of these channels were to be 200 feet wide and 18 feet deep at mean low water. This project required for its execution a larger amount of work than the original scheme called for, namely:

The excavation of 583,530 cubic yards of material, which at 30 cents per cubic yard, would cost	$175,059 00
Contingencies, 10 per cent	17,505 90
Total	192,564 90

The legal measures necessary for securing the right of way across Beard & Robinson's property, at the mouth of the creek, were not completed satisfactorily until May, 1883, and therefore no work was done across the ground in question, although a channel 100 feet wide had been dredged up to this point from Red Hook and up the creek for about 2,000 feet, and the southern channel running towards Bay Ridge had been begun.

No appropriation for this work has been made since that of July 5, 1884, and no work has been done upon it since December 20, 1884. At that time the condition of the channels was as follows:

What may be called the Red Hook Channel, running around the Erie Basin to the mouth of the creek, had been completed for its full width and depth, and the channel of the creek had been widened to 200 feet and had been carried about half way up the creek to a point 2,100 feet below the Hamilton Avenue Bridge. What may be termed the Bay Ridge Channel, lying south of the mouth of the creek, had been begun at its outer or southern end and had been carried up with full depth and width to a point 2,000 feet south of the mouth of the creek.

The following work yet remains to be done under the original project: The completion of the channel up the creek 2,100 feet to Hamilton Avenue Bridge, and the extension of the Southern or Bay Ridge Channel up 2,000 feet further northward, so as to connect with the Red Hook Channel at the mouth of the creek.

A sketch of the condition of this improvement June 30, 1885, may be found in the Annual Report of Chief of Engineers for 1885, page 672, Part I.

Under the existing estimate of $192,564.90, only $65,000 had been appropriated up to June 30, 1886.

The present project ought to be completed. For, apart from the commerce done up the creek and along the Erie Basin, the channel from Bay Ridge to Red Hook is serviceable to passing vessels, for it lies in a bight in which it is stated not only that there is a much longer slack-water than in the main channel outside of the Red Hook Flats, but also that, on account of the eddy formed by the bight, the tide in it makes half an hour earlier than the tide in the main channel, and all tugs and light-draught vessels take advantage of this (say vessels drawing up to 10 feet at mean low water and 15 feet at high water). So soon as the South Channel is deepened to 18 feet at low water vessels drawing from 16 to 20 feet will be enabled to pass.

It is very desirable that enough money be appropriated to complete this improvement; $50,000 could be profitably expended upon it in the next fiscal year.

A statement of the commerce will be found, from 1880 to 1884, in the Annual Report of Chief of Engineers for 1884, Part I, page 707, which gives a fair statement of the commerce of the district; but it is very difficult to obtain accurate figures, especially as regards the passing commerce I have called attention to.

There is a slight shoaling around the southwest corner of the Erie Basin, which will be further examined and if necessary redredged.

APPROPRIATIONS.

Date.	Application.	Amount.
Mar. 30, 1881	Dredging	$40,000 00
Aug. 2, 1882	....do	20,000 00
July 5, 1884	....do	5,000 00
Aug. 5, 1886	....do	7,500 00
		72,500 00
	Amount expended	64,832 26

Gowanus Bay is in the collection district of New York City. Nearest light, Robbins Reef.

Nearest work of defense, the fort on Governor's Island, 1 mile to the northward.

Amount of revenue collected at the port of New York during fiscal year ending June 30, 1886, $132,536,402.02.

Money statement.

July 1, 1885, amount available	$167 74
July 1, 1886, amount available	167 74
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,667 74
Amount (estimated) required for completion of existing project	120,064 90
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirement of section 2 of river and harbor acts of 1866 and 1867.	

E 9.

IMPROVEMENT OF GEDNEY'S CHANNEL, NEW YORK.

Gedney's Channel is the main channel across the Ocean Bar, lying at the entrance to New York harbor, about 3 miles outside of Sandy Hook and east by north from it. Sandy Hook lies about 9 miles outside of and nearly south from the Narrows, which is the name given to the strait separating the nearest points of Long Island and Staten Island, and the Narrows are about 7 miles south from the Battery at the lower end of the city of New York. The Narrows are about 1 mile wide. That part of New York Harbor lying outside of the Narrows is commonly known as the Lower Bay.

From the Narrows northward to New York City there is no water less than 6 fathoms (36 feet) deep in the main channel.

The Lower Bay is a large tidal basin, with an area of about 100 square miles, estimating inside or nothward and westward of a line drawn from Sandy Hook to Coney Island.

The western end of the bay formed by Sandy Hook, the adjacent Jersey shore, and Staten Island, is known as Raritan Bay, and the southern part of it inside of the peninsula of Sandy Hook is known as Sandy Hook Bay, or more commonly as the Horseshoe.

From the northeast around by the east to south-southeast, the Lower Bay is open to the full sweep of the Atlantic Ocean.

From the Narrows to the northern point of Sandy Hook is about 9 miles; but the shortest distance across the bay, from the point of Sandy Hook to Coney Island, is 7 miles. The water cross-section on this line at mean low water is about 790,000 square feet, through which the mean velocity is stated to be 1.6 feet per second; but the maximum velocities are approximately stated to be twice as great (Board of Engineers' Report for 1884).

At the Narrows the channel is about 1 mile wide and 70 feet deep, with depths in it of over 100 feet.

Below the Narrows there is one main channel, commonly known as the Main Ship Channel, running southward to a point about 1 mile west of the upper end of Sandy Hook; thence turning at right angles northward and eastward for four miles to the head of Gedney's Channel; and thence through Gedney's Channel east to the deep waters of the ocean.

But along and inside the above mentioned cross-section of 7 miles between Sandy Hook and Coney Island there is a bar with five distinct channels running through it seaward and eastward, of varying depths.

They lie in the following order, beginning at the northward:

1. *The Coney Island Channel.*—In which the navigable depth at mean low water is 10 feet.
2. *The Fourteen-Foot Channel.*—In which the navigable depth at mean low water is 15 feet.
3. *The East Channel.*—In which the navigable depth of water is 19 feet.
4. *The Swash Channel.*—Through which 23 feet can be carried at mean low water in a narrow channel, but in which are two lumps over which there is a depth of only 21.9 feet.
5. *The Main Ship-Channel.*—In which 24 feet can be carried through channels with lumps in them, with depths of 23.3 feet over them at mean low water.

These five channels are separated by shoals with from 4 to 18 feet of water upon them at mean low water.

The first three of these channels head directly out into the open sea; but the two latter converge into an area of about 2 miles square, lying north and east of Sandy Hook, which has a depth in it of 30 feet of water, and over, and from this deep area, seaward and eastward of it, two channels lead out into the open sea over the outer bar, the northernmost known as Gedney's, the southernmost as the South Channel, both of which have about 24 feet in them at mean low water.

Gedney's Channel is the widest and straightest of the two, and is therefore used by all the large vessels.

The Swash Channel is really a cut-off from the Main Ship-Channel, leaving it about 6 miles below the Narrows, and joining it again at the western end of Gedney's Channel.

Apart from being shoaler, the Swash is much narrower than the Main Ship-Channel.

The distance from the Battery, at New York, to 30-foot soundings outside the bar in Gedney's Channel is 22 miles; and by the Swash it is 18 miles or from the Narrows 15 and 11 miles respectively.

The Main Ship-Channel has a depth of 30 feet at mean low water through its entire length, with these exceptions, namely:

(1) At a point 8 miles below the Narrows, commonly known as the Knolls, where the channel passes between Flynn's Knoll on the east, and a corresponding lump or knoll on the west; here there is a shoal about 2 miles long between the 30-foot contours and 2,000 feet long be-

tween the 24-foot contours, with a minimum depth upon it of 23.3 feet at mean low water. On either side of the crest of this shoal is a narrow crooked channel with over 24 feet of water in it; but neither is wide enough for the deepest draught vessels to work through.

(2) The second point at which there is less than 30 feet of water is in Gedney's Channel and in the western approach to it from the Main Ship-Channel.

In Gedney's Channel proper, this spring, there was a bar 4,500 feet long between the 30-foot contours, with a minimum depth on it at mean low water of 23.8 feet for a width of 800 feet on the north side, and a minimum depth of 21.9 feet for 200 feet south of this. This has since been deepened by dredging.

The western approach to Gedney's Channel from the Main Ship-Channel has also a less depth than 30 feet, being obstructed by a bar 2,000 feet long, with a depth on it of about 28 feet.

A comparison of the survey made by Major G. L. Gillespie, Corps of Engineers, in 1884 (see Annual Report of the Chief of Engineers for 1885, pages 776 to 785), with those previously made, shows that the changes which have occurred in the channels since 1835 have been very slight.

The 24-foot curves of the Main, Swash, East, and Fourteen-Foot channels have all moved slightly westward and southward, but still embrace about the same areas of shoals.

But while, in 1835, bars with less than 24 feet on them extended completely across Gedney's, the Main Ship, and the Swash channels, these bars, at the time of Colonel Gillespie's survey in 1884 had nearly disappeared, leaving in each case only spots where there was less than 24 feet of water.

For fifty years, then, it will be seen that the natural tidal scour, which is strong enough at the Narrows to maintain a channel a mile wide, with depths of 100 feet in it, has been only able below the Narrows to maintain a 30-foot channel, with two spots in it where there is 24 feet depth.

From current observations, taken, by Colonel Gillespie in 1884, it appears that a good deal of the ebb volume from the Narrows passes to the northward of the south side of the Swash Channel, and that a large part of the Raritan Bay ebb volume passes between the south side of the Knolls and Sandy Hook, leaving a wedge-shaped area at their junction near the Knolls, over which the rate of current is reduced about one-half, and where a part of the current passes directly across the channel instead of along its axis.

This is also true of the flood tide; on the flood there is the same diminution of rate across this area, and a part of the tide crosses the channel at right angles. Some of the velocities observed by Colonel Gillespie in 1884 in these channels are as follows:

Localities.	Maximum ebb (miles per hour).	Maximum flood (miles per hour.)
In the Swash Channel, abreast of the Romer Beacon	1.60	1.21
In Main Ship-Channel on the Knolls	0.80	0.65
Close off the point of Sandy Hook, and due north of it	2.22	1.70 to 1.20
In the deep hole half-way between Sandy Hook and Gedney's	2.00	1.50
In Gedney's Channel	1.60	1.30

Both in the Swash and in Gedney's Channel the ebb current is nearly parallel with the axis of the channels, and from the measurements so far taken the relative ebb velocities in both channels appear to be the same, but the flood in Gedney's Channel appears to exceed that of the Swash Channel by 0.09 miles per hour.

In the spring of 1872, Brig. Gen. (then Lieut. Col.) John Newton, Corps of Engineers, had a series of current observations taken in the Lower Bay, with the following results:

Place.	Surface velocity, in miles per hour.	Bottom velocity, in miles per hour.
Fourteen-foot Channel	2.20	0.40
East Channel	1.65	0.90
Swash Channel	2.00	0.40
Main Channel Close to and due north of the point of Sandy Hook	2.40	0.80

These observations were stated to have been taken at the maximum velocity of the ebb tide, but no observations were taken either at the Knolls or in Gedney's Channel.

The current velocities given by the Coast Survey charts are, for the channels over the outer bar: Flood, 1.4; ebb, 2.2 miles per hour. Main Ship-Channel: Flood, 1.1; ebb, 2 miles per hour. The rates resulting from these three sets of observations differ so much that it is evident that there must have been some local or temporary conditions affecting them, and they do not therefore furnish the means of making an accurate or even an approximate estimate of the amount of tidal flow in and out of the harbor, or even of the direction of its motion.

The agencies tending to diminish the navigable depths through the channels of the Lower Bay of New York are, briefly—

(1) The movement of sand westward along the south shore of Long Island, and northward along the outer shore of New Jersey and Sandy Hook.

(2) Wave action, which picks up the material from the shoals and deposits it in deeper water, when the wave action itself is lost.

(3) Sediment, in the drainage water from the land.

(4) The deposit of dredged material or garbage.

But in view of the fact that during fifty years there has been a tendency in the channels to deepen rather than to shoal, these agencies seem to have been arrested or counteracted by the natural scour.

Gedney's Channel is 2½ miles from Sandy Hook Beach and 4½ from Long Island.

The ebb current through it is almost exactly parallel with the axis of the channel, but the flood appears to have a more northerly direction.

The material composing the bottom is large, coarse sand and gravel, like that on the Sandy Hook Beach; while that on the Coney Island Beach is fine sand.

There are no shoals outside of Gedney's Channel, and the heaviest wave action comes from the direction of the ocean.

As yet no trace of sediment that looks like that of land drainage has been found in Gedney's Channel, although it is found in the deep hole directly inside and west of it.

The dredging in Gedney's Channel since February has failed to show any trace of dumped material or garbage.

New York Harbor has two dumping places designated by and controlled by the State of New York; one in the Sound, and one about 2 miles north-northeast of the outer end of Gedney's Channel, and about 3 miles south of Fire Island Inlet, on the Long Island Beach.

The observation of the assistant engineer and inspectors employed upon Gedney's Channel since February of this year shows that at least 90 per cent. of the dredged material coming through the Narrows in the dump-scows from New York Harbor is taken out through the three channels north of the Swash; and this for the simple reason that it is from 4 to 6 miles shorter through these channels to the dumping point than by the Swash. Once in a while, in a heavy cross wind, and against a tide, a tow of dump-scows is unable to keep to the north of the Romer Shoal, and has to come down the Swash; but, then, after passing the Romer they head up again northward of Gedney's Channel to the dumping-ground.

So it may be said that the only two shoal places in the Main Channel leading out of New York by way of Sandy Hook which are in the Main Ship Channel at the Knolls and in Gedney's Channel, respectively, never have a dump-scow pass over them.

In the case of being caught in a storm, and having to dump "short," or doing so to save time, which undoubtedly occurs at times, this would be done to the northward of the Main Ship, Gedney's, and the Swash channels.

It seems to be the general opinion that most of the illegal dumping is done at night above the Narrows, generally on or along the edge of the Red Hook and Communipaw flats.

The above are briefly the chief physical characteristics of the *Lower Bay* of New York.

The largest steamships running out of New York at present draw 28 feet loaded, but few load down to this depth.

Major Gillespie, in 1884, reported that the deepest-draught vessel that had ever entered New York Harbor was the Spanish frigate Numancia, which drew 28 feet 8 inches, but that she had to wait for a spring tide to cross the bar.

The minimum depth of water in the Main Ship Channel at mean low water in February, 1886, was 23.3 feet, to which must be added 4.8 feet for mean rise of tide, which would give a minimum depth of 28.1 feet at mean high water, or only one-tenth of a foot more than the draught of the largest ocean steamers at present.

Slack water at Sandy Hook averages about 40 minutes, so that the vessels of deep draught have only 40 minutes in which to cross the bar in Gedney's Channel, and to pass the Knolls, 7 miles above it.

It is common to see vessels passing over the bar with a wake 500 to 1,000 feet long behind them of material churned up from the bottom by their propeller-blades. A vessel too close to the bottom will not steer either, but sheers from side to side, and is liable to run out of the best water. This occurred with the Aurania in April of this year when coming in. While making the turn at the Knolls she took a sheer, and the anchor had to be dropped in order to prevent her from running aground. Hence the story arose that she had run aground. Thirty feet at mean low water appears to be the depth which is required to enable the largest ocean steamships to come in with 2 feet to spare below their bottoms.

Up to July 5, 1884, no money had ever been appropriated for the improvement of the Lower Bay and its channels, and no work had been done. But on that date, without any preliminary examination, survey, or report, an appropriation of $200,000 was made by Congress for "deepening Gedney's Channel, New York Harbor."

Maj. G. L. Gillespie, Corps of Engineers, then in charge of the New York Harbor improvement, by direction of the Chief of Engineers, immediately began an extended survey of the Lower Bay and its channels, which was completed during the autumn of 1884; and on December 6, 1884, he made a formal report to the Chief of Engineers, with accompanying maps and plans.

The report is published in the Annual Report of the Chief of Engineers for 1885, Part I, pages 775 to 783.

The report stated that there had been no shoaling in the channels of the Lower Bay since 1835. That, on the contrary, the channel depths has slightly increased, as was also indicated by the Coast Survey charts of 1881 and 1883.

The growth of Sandy Hook was explained, showing that between 1752 and 1868 the northern point of the Hook advanced 5,400 feet northward. That from 1868 to 1884 it had "progressively receded, until it had reached the position of 1835, with an added western extension of 1,200 feet."

The recession of the Hook made no appreciable changes in the depths of the channels near it.

Borings to the depth of 3 feet below the bottom were made in the channels and on the surrounding shoals, and current observations were made in the Swash Channel, Main Ship-Channel below the head of the Swash, and in Gedney's Channel.

Among the maps prepared was a comparative map, showing the 24-foot curves in 1835, 1855, 1881, and 1884.

After a description of the channels and the material forming them Major Gillespie then stated:

(1) That it had been proven for the last fifty years that the ebb scour would maintain a channel across the bar between Sandy Hook and Coney Island from 21 to 23½ feet deep at mean low water.

(2) That the surest way to increase this depth would be to contract the width of the water-way by means of a low dike extending from near Coney Island towards Sandy Hook, thereby diverting a part of the ebb current from the more northerly channels across the bar, and directing it into the main channel, so as to secure an increased scour there; but as a work of this kind would be very expensive, and as the law relating to the appropriation specified that the $200,000 should be applied to "deepening Gedney's Channel," it was deemed inexpedient to attempt to deepen it in any other way than by dredging; a method which had proved successful on the sea-bars at the mouth of the Tyne and of other European rivers.

In his report he said:

> I do not know that the cut once opened will be self-maintaining, but the present appropriation being small, it is well enough to experiment with it, and if the experiment is moderately successful the use of large sums for contraction by stone structures may be avoided, and the annual appropriation for maintenance placed at a low figure.

Major Gillespie's estimates were as follows:

For deepening Gedney's Channel and the Main Ship-Channel at the Knolls to 30 feet at mean low water and making these channels 1,000 feet wide.

I. GEDNEY'S CHANNEL.

Excavating a channel 1,000 feet wide, 30 feet deep, at mean low water, 700,000 cubic yards, at 50 cents	$350,000

II. MAIN CHANNEL.

Excavating a channel 1,000 feet wide and 30 feet deep, at mean low water, through the Knolls, 1,550,000 cubic yards, at 40 cents	620,000
Total	970,000

But he states that in the above estimate no allowance is made for irregularities of cutting, or for increase of bulk, should the material be measured in scows, and that this increase would amount to 30 per cent. for a 30-foot channel.

Actual experience in dredging from February, 1886, to June 24, 1886, shows this increase to be roughly as 55 to 40, so that to Major Gillespie's estimate should be added in round numbers $150,000 for Gedney's Channel, and $250,000 for the Knolls, making the totals—

Gedney's Channel	$500,000
The main channel	870,000
Total	1,370,000

This is the amount required at Major Gillespie's estimate of 50 cents per cubic yard in Gedney's Channel and 40 cents per yard in the Main Channel.

From the experience gained in this year's work it is believed that with the construction of proper plant the work would not cost more than one-half of these amounts.

Major Gillespie's report was referred to the Board of Engineers for Fortifications and for River and Harbor Improvements December 10, 1884, and their report may be found in the Annual Report of the Chief of Engineers for 1885, Part I, pages 783 to 787.

After examining the questions involved, they briefly recommended—

> As a general plan for improving the entrance to New York Harbor so as to give 30 feet from New York to the ocean, the construction of a half-tide stone dike running about south-southeast from Coney Island to such a distance as may be found necessary, and probably not less than four miles; the protection of the head of Sandy Hook, and the dredging of a 30-foot channel 1,000-feet wide from deep water near Sandy Hook to deep water below the Narrows, also the immediate dredging of a channel 1,000 feet wide and 28 feet deep, through the shoal west of Flynn's Knoll, as soon as Congress shall furnish the funds. Also, that the existing appropriation be applied to dredging Gedney's Channel to a depth of 28 feet.

The total estimated cost of this improvement was from $5,000,000 to $6,000,000.

The purpose of the dike, as before stated, is to turn into the main channel a part of the ebb current which now flows over the neighboring shoals without reducing the volume of tidal flow in and out of the harbor. For this reason the dike is at first to be brought up only to the low-water level, and subsequently, should it become necessary, to the level of half-tide.

In order to accomplish the purpose for which it is designed, it is not necessary, as has been feared in some quarters, that the dike should be made to close the minor channels through the bar between Coney Island and Sandy Hook. As stated, however, in the report of the Board of Engineers, to whom the question was referred, the exact extent of construction necessary for securing the result desired can be determined only by trial, as was done at the mouth of the Mississippi, and as is done in all important works of harbor improvement. The report was approved by the Chief of Engineers; and Major Gillespie was directed to advertise for deepening Gedney's Channel under the existing appropriation.

The exposed position and frequent storms on the bar, the great depth of water, and other unfavorable conditions, made it a difficult matter to decide upon the best mode of deepening Gedney's Channel.

It was not expected that ordinary clam-shell and dipper dredges could be used there to advantage, and therefore in drawing up the specifications for the work provisos were inserted requiring bidders to furnish plans and descriptions of the plant they proposed to use, and also a proviso that, if after the plant had been in use a reasonable time, and had not obtained good results, the contract should be annulled, and the contractor should be reimbursed a fair amount for his outlay.

Bids for this work were opened January 15, 1885.

The lowest bidder was the firm of Morris & Cumings, who proposed to do the work at 35 cents per cubic yard, with clam-shell dredges and centrifugal pumps.

But apart from the fact that the bid of Morris & Cumings was irregular, there was a bid from Roy Stone, of New York, for deepening the channel by means of what he termed "hydraulic plowing," a process which consists in stirring up the material composing the bottom by means of a strong jet of water thrown against the sandy bottom during the ebb tide, which the projector thought was strong enough in Gedney's Channel to carry away the material so loosened.

As Mr. Stone's offer carried with it no obligation of payment on the part of the Government, unless he should deepen the channel to 28 feet for a width of 200 feet to begin with, and as it was certain that the ordinary means of dredging could not be successfully used in a place so much exposed to sea-action as Gedney's Channel is, it was decided to accept Mr. Stone's bid; but as very little confidence was felt in the success of this process, though it seemed expedient to give it a trial, the time for completing his contract was limited to June 1, 1885, and, if at that time satisfactory results had not been obtained, the contract was to be annulled without any payment being made to the contractor.

A contract to this effect was therefore entered into with Mr. Stone, February 7, 1885, and on the 24th of March work under it was begun.

From the outset the method was unsuccessful, and after a short time an induction pipe was substituted for the water jets, which was expected to draw the material up to the surface of the water and thereby give it a better chance of being carried off by the current.

This, however, proved no more successful than the first method, and on the 14th of May, 1885, Mr. Stone was released from the contract at his own request. No money was paid him by the Government.

Major Gillespie immediately wrote to Morris & Cumings to ask if they wished to enter into a contract under their bid of January, but they refused, and the work was readvertised May 21, 1885, and proposals were again opened June 23, 1885. An abstract of the bids may be found in the Annual Report of the Chief of Engineers for 1885, Part I, page 772.

The prices of the bids varied from 33 cents to $1.50 per cubic yard.

Mr. Stone was again the lowest bidder, at 33 cents, but from being unable to prove his ability to execute the contract, his bid was thrown out.

The second lowest bid was that of the Atlantic Dredging Company, at 47 cents per cubic yard. Their method was not specific; the date of commencement too remote, and the time for the completion of the contract not given.

The same may be said of the third lowest bid, that of Michael Murray, at 53 cents per cubic yard, except that his individual responsibility did not seem as good as that of the Atlantic Dredging Company. These two bids were therefore thrown out, and the contract was awarded, with the approval of the Chief of Engineers, to the next lowest bidder, Elijah Brainard, at 54 cents per cubic yard.

Mr. Brainard proposed to put upon the work, within two weeks of signing the contract, three clam-shell dredges, with a capacity of 4,000 cubic yards per day, and further, to build and put on within three months of the date of opening the bids a hydraulic-pump excavator, with an estimated capacity of 2,500 yards per day.

The contract with Mr. Brainard was signed July 25, 1885, but as it was found impracticable to keep a scow alongside of the clam-shell dredges in the rough water on the bar, it was not thought advisable to attempt to put them at work. On the 26th of September, 1885, the hydraulic excavator was ready and began work.

The following is a brief description of this excavator:

In the after end of a large dredging dump-scow is placed a centrifugal pump, with an estimated discharge when making 280 revolutions of 16,000 gallons per minute through a 16-inch pipe.

An iron suction-pipe 16 inches in diameter and trussed to give it strength is connected with a universal joint set on the stem of the scow. From the universal joint the pipe is connected with the pump by flexible india-rubber tubing reinforced with steel springs. This tubing allows for the play of the universal joint during the pitching and rolling of the boat.

The suction-pipe, 68 feet long, is raised up from and let down upon the bottom by falls attached to derrick frames extending over the end of the scow when resting on the bottom. In 30 feet water it lies at an angle of about 45°, and when triced up it is parallel with the surface of the water.

At the lower end of the pipe in an iron frame, 6 feet by 8 feet, and about 1½ feet deep, which prevents the end of the suction-pipe from touching the bottom. The mouth of the pipe is led into the center of this frame and is raised about 9 inches above its bottom. The lower side of this frame is fitted with iron teeth which are supposed to loosen the material on the bottom. The mouth of the suction is protected by an iron grating with openings in it 5 inches square.

From the pump the water and material raised are forced through a 16-inch iron discharge pipe leading over the centers of the pockets or bins which hold the material; over each pocket there is T pipe leading downwards, fitted with a flanged door, so that any one pocket can be filled independently of the rest.

The scow itself is about 120 feet long, 40 feet wide, and draws from 11 to 12 feet loaded; its full carrying capacity is 694 cubic yards.

In going out to or in from the dumping ground the suction-pipe is disconnected at a socket-hinge a few feet outboard from the universal joint, and is triced securely to the derrick-frame overhanging the end of the scow.

The scow is not self-propelling, but is towed by a powerful steam-tug, which can make about 8 miles per hour with the scow in favorable weather with the tide.

On arriving at the channel the scow is towed up and down it at from ½ mile to 2 miles per hour; and when the pockets are filled with solid material the scow is towed out to 90 feet water, in the vicinity of Sandy Hook lightship, and the material dumped through center doors in the bottoms of the bins.

It was expected by the contractor that this machine would raise from 10 to 20 per cent. of solid material, which would correspond to 2,000 to 3,000 cubic yards per day. The amount actually raised was less than 5 per cent.

The machine, however, was largely experimental, and, as is the case with all new and untried machines, was subject to frequent breakdowns.

Its work was also begun too late in the season, when storms became frequent.

Beginning September 26, 1885, only 57 hours and 40 minutes actual pumping was done up to December 23, 1885, when, in a storm, going out to the dumping ground, the A-frames, derrick-frames, and suction-pipe were carried away, and the excavator had to be laid up for repairs. In the 57 hours 40 minutes pumping 6,411 cubic yards of solid material were excavated.

The repairs consisted in replacing the old engine with a new one of double power, the derrick-frames were rebuilt and strengthened, the suction-pipe was reinforced with a truss, condensers were put in, and various minor repairs and improvements were made, and the excavator was ready for work again February 24, 1886.

Meanwhile, under date of January 2, 1886, Major Gillespie notified the contractor by the following letter that the plant did not come up to the capacity called for by the specifications:

UNITED STATES ENGINEER OFFICE,
New York, January 2, 1886.

SIR: By your contract, dated July 31, 1885, you are required to furnish a plant for use in Gedney's Channel capable of removing 3,000 cubic yards of material per diem, and are also required to complete your contract by June 30, 1886. Five months have now elapsed, and your plant has scarcely gotten beyond the experimental stage; the trials you have given it indicate pretty conclusively that it has not a maximum capacity beyond 1,000 cubic yards per diem. This result is far below the expectations of the contract, and I hereby give you notice that if you do not have in readiness by April 1 next an increased plant capable of removing daily the quantity required by the contract, this office will feel itself authorized to go into open market and supply the deficiency, charging to you all the expenses of such charter over and above the contract price of removal embodied in your contract.

Very truly,

G. L. GILLESPIE,
U. S. Engineers.

Mr. ELIJAH BRAINARD,
Contractor for Gedney's Channel Improvement.

Mr. Brainard replied, in the following letter:

NEW YORK, *January* 5, 1886.

DEAR SIR: Yours of the 2d instant, relative to my contract for improving Gedney's Channel, is received. It is my intention to work additional plant after April 1, 1886, said plant to be of the same design as the one now used and to be of more than double its capacity. Construction of same will be commenced immediately, and completed on or about March 15, 1886. With the experience already had I have no hesitation in saying that without doubt the new plant will be capable of excavating from 3,000 to 3,500 cubic yards per diem. It will be of the most improved construction. Expect to complete repairs on our present plant this week, and be ready to again start on the work Monday. Will also place on the work, on or about January 15, additional plant, the one formerly used in Charleston Harbor, South Carolina.

Very respectfully yours,

ELIJAH BRAINARD,
B.

Col. G. L. GILLESPIE,
United States Engineers.

Plans and specifications for the new plant were immediately got up by Mr. Brainard and contracts let for the work on it.

Owing to bad weather in the winter months, and to the natural delays to be expected in the construction of such a large and complicated machine, it was not finally finished until May 29, 1886.

This excavator, which will be known as excavator No. 2, is a larger and improved form of No. 1; the hull was especially built for the purpose; its dimensions are 152 feet by 44 feet, and it draws about 16 feet loaded; it is scow built, with 6 pockets and bottom dump-valves. The pump is similar to that on No. 1, but it is set about 8 feet lower. The capacity of the pump, as estimated by its makers, is 36,000 gallons per minute, through a 22-inch suction and a 22-inch discharge-pipe.

Her loaded capacity is 1,055 cubic yards when full. She is not self-propelling, but is towed as No. 1.

Meanwhile, Mr. Brainard's statement that he would put the self-propeller Howard upon the work, in addition to the other plant, was not verified till May 9.

The Howard, which was working last season on Charleston Bar, is a self-propelling steam barge, about 110 feet by 32 feet, and draws about 10 feet. An Edwards pump, capacity unknown, is set low amidships. There are two suctions, one on each side, 9 inches in diameter.

The load is carried on an upper deck forward, in bins, which dump through side doors. Her full loaded capacity is about 175 cubic yards.

The following is a detailed statement of the work of the three excavators since they commenced work under this contract:

EXCAVATOR NO. 1.

Month.	Cubic yards excavated.	Actual time pumping.		Time lost by repairs.		Time lost by storms.	
1885.		*Hrs.*	*Min.*	*Days.*	*Hrs.*	*Days.*	*Hrs.*
September	70	3	25	2	00	1	00
October	1,377	21	00	15	00	4	00
November	1,146	7	31	19	00	2	00
December	3,818	25	44	18	00	2	00
1886.							
January	....	....		31	00	....	
February	....	....		22	00	6	00
March	4,595	33	33	....		17	4
April	6,563	64	54	1	28	15	30
May	16,410	127	10	....		7	16
June	12,289	111	24	6	00	7	00
July	17,667	124	18	5	00	2	00
Total	63,935	518	59	....		....	

EXCAVATOR NO. 2.

1886.							
May	862.7	3	44	2	00	....	
June	21,385	109	54	6	00	2	00
July	22,447	88	27	11	00	1	00
Total	44,684.7	202	5	....		....	

HOWARD.

1886.							
May	5,717.88	91	18	7½	00	2	00
June	12,484.65	125	48	4	00	2	00
July	11,378.87	133	51	3	00	1	00
Total	29,581.40	350	57	....		....	

RECAPITULATION.

	Cubic yards.
Excavator No. 1	63,935.0
Excavator No. 2	44,684.7
Excavator Howard	29,581.4
Total to July 31, 1886	138,201.1

From the 23d of December to the 23d of February no record was kept of the days on which Excavator No. 1 could have worked; but judging from the wind velocities there were 24 days of south southwest to northeast winds on which she could not have worked, irrespective of heavy blows from northwest and running ice.

The record shows that the maxium capacity of the plant, so far, is as follows:

	Cubic yards.
No. 1	1,196
No. 2	1,996
Howard	664
Total	3,856

in a working day of about fifteen hours; that the Excavator No. 1 can excavate and dump two loads of about 550 yards in that time, about half the time being devoted to actual pumping and the other half to going out to the work and returning, going out to the dump and back, and in turning at the ends of the cut, and that her average pumping when in good order is 2.4 cubic yards per minute.

Excavator No. 2 will excavate under favorable circumstances two loads of nearly 1,000 yards each, in the same time, and her average pumping when in good order is between 4 and 5 cubic yards per minute.

Both of them appear to lack engine and boiler power, No 2 especially.

It was expected that the engine of No. 1 would average about 80 revolutions per minute, and it rarely gets over 70, even with the help of a blower.

No. 2 was expected to average 75 revolutions, and it rarely gets over 52, even with the help of a blower. It is noticed that a few extra revolutions make a most marked increase in the percentage of solid material.

For too many reasons to give here in detail, no even approximately fair idea has been obtained of the relative percentage of solid material and water raised. It is safe to say that it has never run 5 per cent. of solid for a continuous hour on the estimated capacity of the pumps. The moment the suction is dropped on the bottom the volume of the discharge decreases about one-third, and, if the suction chokes at all with solid material, the discharge dwindles down to a small stream.

The break-downs on excavators 1 and 2 since February have been almost all connected with pumps and suctions, the suctions especially, the breaks usually occurring near the shoe, or near the universal joint; the flexible rubber tubing connecting the universal joints with the pumps have also given a great deal of trouble, as, apart from the ordinary wear and tear, they buckled very much.

Much time was also lost in experiments to find the right height to keep the lower ends of the suctions above the bottom, and also the heights above the bottom at which the gratings should be placed; it was found, in either case, that a difference of one inch would increase or decrease the flow of solid materially.

The self-propeller Howard can excavate and dump in a working day of 15 hours as high as four loads, of a little over 150 cubic yards each, pumped in 6 hours actual pumping, which gives about 1.7 cubic yards per minute.

The Howard has worked more steadily and can work in a heavier sea than the other two excavators. Her repairs have been confined almost entirely to the engine, boiler, and suctions; but she has this advantage over the other two, that the suctions can be repaired very easily, sometimes without leaving the dredging ground. She has the same lack of engine and boiler power that the other two have.

Her pump does not choke as readily as the others. This was specially noticeable when pumping on the mussel-bed on the south side of the channel. The two large excavators choked continually, which necessitated raising the suctions off the bottom for half a minute or more at a time, while the Howard's pump did not choke more than usual.

The mode of conducting the work has been as follows:

Four spar-buoys were placed on the north side of the channel to be dredged, located by sextant angles to the Centennial tower on Coney Island, the Romer Beacon on the Romer Shoal, and the Main Light of Sandy Hook; the geographical position of these fixed points on shore was obtained from the Coast Survey. On account of side winds, cross tides, wave action, and passing vessels it was not possible to confine the operations of the excavators to any accurate alignment.

When work was resumed in March the excavator was at first confined to a space 300 feet wide south of this line of buoys, which was subsequently increased to 400 feet. Over this area the excavator was towed up and down the channel at a rate varying from half a mile to 2 miles per hour, according to tide and wind.

It was expected that the very small amount of material taken out in crossing over the bar each time in connection with the devious course of the excavators, owing to wind and tide, would counteract any tendency to excavate more deeply in one place than in another; this expectation has been borne out fully, the soundings taken showing the same general contours which existed before dredging commenced, with increased depths over them, but with no greater unevenness.

When the Howard was put upon the work, May 9, the same system was kept up; and both plants were confined to the 400-foot area south of the northern line of buoys. When excavator No. 2 was put upon the work, May 29, it was manifest that the three excavators could not work in such a narrow space, on so short a bar, and therefore a second line of four buoys was located on the southern side of the channel to mark the southern limit, and the excavators were allowed to work on both sides of the channel, confining their operations to a space 400 feet wide on the channel side north of the southern line of buoys, and to the same space as before on the northern side of the channel, south of the northern line of buoys.

The two lines of buoys were placed 1,100 feet apart, because as the proposed width to be given to Gedney's Channel was 1,000 feet, and it was not practicable to work nearer to the buoys than 50 feet on account of the danger of the excavator continually fouling or carrying away the buoys with their suctions, it was necessary to set the buoys 50 feet outside the channel lines. The reason for going over to the south side of the channel, and leaving untouched a width of 200 feet in the middle, was that the southern side of the bar was the shoalest part of it; and the central part the deepest; and also that at the western end of the bar on the south side, a large bed of live mussels extended out into the channel for a width of 400 feet in the widest place, and a length of about 1,200 feet along the channel. It was thought that this bed had the effect of checking the natural scour, and that if removed it would give the currents a better chance of scouring.

Up to July 12, therefore, the excavator was kept on these two 400-foot areas, south of the north line and north of the south line of buoys, respectively, when soundings with the lead-line showed increased depth on both sides of the channel, giving practically a 26-foot channel on the north 400 feet, and a 24-foot channel on the south 400 feet, the intervening space between them having a depth of nearly 25 feet.

The excavators were, therefore, taken off the north side and set to work on the middle 200 feet, as nearly as practicable, and when it became necessary to turn out of this area in order to pass each other, or passing vessels, they were required to keep on the southern side of the channel, as being the shoalest.

The soundings in continuation of those taken on the 12th of July, which should have been made on the 13th and 14th, but which could not be then made on account of bad weather, were taken on the 19th and 20th, and showed that the middle 200 feet had been excavated to a depth of 25.3 feet in the shoalest place. The excavators were, therefore, directed to work on the whole width of 600 feet north of the southern line of buoys. It was expected to get another set of soundings before the close of July, but the weather was too hazy to obtain sextant angles.

At the close of July, therefore, there was a channel 700 feet wide and 26 feet deep, measured with a lead-line, and with one spot in it of 25.3 feet deep on the north side of Gedney's Channel, where a minimum depth of 23.7 had originally existed; and on the southern 300 feet of the width of 1,000 feet proposed to be dredged there was a least depth of 23.9 feet where a depth of 21.8 had previously existed, both being reduced to the common plane of *reference used by* the Coast Survey.

The excavators have not worked at night. On good working days they have left their anchorage in the Horseshoe at Sandy Hook, from half past 3 to half past 4 in the morning, so as to get to the bar at daylight; and after working through the daylight hours, have returned to their anchorage at any time from half past 7 to half past 10 in the evening, after they had dumped their last load; so that their average working day may be estimated at fifteen hours.

As the excavator started out at different times in the morning, came in at different times at night, and started for the dumping-ground at different times, and as in many cases where the excavators could work it would have been impossible on account of the sea to put an inspector across from one excavator to another in a small boat, it was necessary to keep one inspector on each excavator whose duty it was to keep a record of the pumping, delays, repairs, time lost in going out to the dumping-ground, and of the kind of material removed, and also to keep the excavator within the proper ranges, to measure the loads, and to see that the material was dumped in the proper place. From March 26 to the end of July, Maurice Kingsley, the assistant engineer in local charge of the work, went down to the channel in the United States steam-tug Humphreys on an average three days a week, to superintend the work, to see that the buoys were in position, and when necessary to take soundings.

The material excavated up to July 31 shows that the bottom differs from the description of it given in Major Gillespie's report of December 6, 1884, only in these respects, namely: That the live mussel-bed extends into the channel on the south side, as mentioned before in this report; that there is a layer of débris of dead mussels and broken shells extending from the live bed across the channel to the north side; and that there are a few pieces of material larger than Major Gillespie's borings could show with the size of pipe used.

When dredging was begun this spring on the north side of the channel it was noticed that the pumps brought up, near the western end of the channel, a mixture of sand and the shells of dead mussels broken up into fine pieces. In one place the débris was so fine that it is a blue mud, remaining in suspension a very long time; and, when looked at through a magnifying glass, proving to be only the finest imaginable particles of mussel-shells. Just to the east of this area of mussel mud, as it may be called, the excavators bring up a yellow mud of the same kind. Both have an exceedingly offensive smell.

On commencing work on the south side of the channel a bed of live mussels was found extending out into the channel northward about 400 feet, and eastward and westward about 1,200 feet, commencing at the western end of the channel and running east. This is evidently the continuation northward of the mussel-bed southeast of Black Can Buoy No. 3, mentioned in Major Gillespie's report of 1884, but which his borings did not locate so far to the northward.

The bed appeared to be from 6 to 10 inches thick, underlaid with "pea gravel," to which the mussels adhered. Large bunches were brought up by the pumps, with from 10 to 50 mussels in a bunch, and some of very large size. The bed was so thick that in a load of the excavator Howard, one of the after bins, which holds about 30 cubic yards, must have had no less than 5 cubic yards in it of live mussels. By July 12 large live mussels had almost entirely disappeared; once in awhile a bunch was brought up between that date and the 31st of July, but very rarely. The mussel débris and mussel mud have continued to be brought up. One of the Sandy Hook pilots, whose pilotage dates back to 1834, stated to Mr. Kingsley, the local assistant, that he remembered when this live mussel-bed extended the whole way across Gedney's Channel; but that since then the northern part had been destroyed by propellors churning it up in passing over it. This is very likely to be the case.

The deepest water has been for many years on the north side of Gedney's Channel. The mid-channel buoy at the western end of Gedney's has not been, up to July 31, in mid-channel, but about 300 feet to the southward, giving a width of about 700 feet on the north side and 300 feet on the south side between the 23-foot contours.

All of the deep-draught steamers and vessels keep to the northern side of this buoy, and a line drawn east from a point 100 feet north of this buoy along the axis of the channel would just about strike the northern edge of the live mussel-bed when the dredging upon it began, which is just about the southernmost line that deep-draught vessels take in going out or coming in through the channel.

Apart from the mussel-bed, and mixed in with the mussel débris, the material in Gedney's Channel consists of a layer of sharp quartz sand, varying in color from almost white to a ruddy orange. There appears to be no regularity in its color, except that the sand on the eastern end of the bar is of a darker color than that on the western end. Interspersed slightly with this sand is a small round water-worn quartz gravel, which on other parts of the bar becomes a gravel from the size of a pea to the size of a goose's egg. The majority of this gravel, perhaps 70 per cent., is what has been called "pea-gravel."

On resuming work in March, 1886, this gravel was found at the western end of the bar, and only coarse sand was found at the eastern end; but since then it has varied a good deal, and from what has been shown during the progress of the work there appear to be alternate layers of gravel and sand, extending over the bar, without any very definite location and without having any very regular depths. Up to July 31, 1886, it was noticed that the material was gradually becoming finer as the depth increased, but since that time the material became heavier again, and at the present time of writing has been getting lighter, and it appears to be the case that the material in Gedney's Channel as a rule is somewhat lighter in the middle and at the eastern end than it is at the western end and on the sides.

No evidence whatever has been found of the mud-dumps and dumped material so often spoken of by newspapers and persons unacquainted with the channel, except a few large cinders scattered along it, which have been thrown overboard by passing steamers.

Sandy Hook pilots state that they often stop ocean steamers from dumping their ashes overboard in the channels when going out, and on the 2d of July, 1886, John Parsons, inspector of the excavator Howard, saw ashes being dumped overboard from the steamer Bempton, of London, as she passed through Gedney's Channel out to sea at 11.30 a. m. He called the attention of the crew of the Howard to it, in order to have witnesses. The steamer is not one of the regular transatlantic lines, and has not returned to this port since.

The amount of cinder dredged up is so small that no accurate estimate could be made of it; but it is safe to say that out of 138,000 cubic yards of material excavated from Gedney's Channel up to July 31, 1886, the total amount of cinder was not more than 50 cubic yards. It is pumped up all over the bar, and no large deposit is found in any one place.

A few pieces of water-worn sandstone have been pumped up of very irregular shapes, the largest which have passed through the pumps being 13 by 8 by 5 inches. All the large pieces have passed through or blocked the pumps, when the gratings over the mouth of the suctions have been disarranged. Nothing can now get through them over 5 inches cube.

The gratings and pumps have been choked with this large material several times, and there is undoubtedly more of it than is pumped up.

Fish, shell-fish, shells, and marine animals are brought up in large quantities, and usually there are from 1 to 3 bushels of small crabs brought up and dumped in each load.

It is well to mention that since July 31 little bunches of very small mussels have been brought up in noticeable quantities on the space formerly covered with the live mussel-bed, indicating a new growth since the first dredging was done over it.

There are strong indications that the channel is underlaid at the eastern end with blue clay at from 33 to 35 feet below mean low water. Whenever the suctions are dropped a little too soon at the western end, starting eastward, pieces of compact blue clay are brought up. The western end of Gedney's pitches down into a deep hole, 40 feet deep and over, almost perpendicularly, and it is on the edge of this deep hole that the clay is found; but it is evidently a very old formation and entirely different from the soft mud of which the bottom of the deep hole is composed.

At a rough estimate, over 60 per cent. of the material of large size, where the surface is rough, is over-grown to a more or less extent with sea-growth of various sorts, indicating that the stones have not had sufficient scour or wear to prevent such growth, and it may, therefore, be assumed that they have lain in Gedney's Channel a long time.

It has been found that there is sufficient room in Gedney's Channel to work the three excavators at the same time, except just at high water on Thursdays and Saturdays, when the North Atlantic fleet of steamers passes over the bar, when one and sometimes two of the machines have to be laid off for half an hour or an hour.

The two large excavators, which are towed, have been at a great disadvantage, on account of the length of tow-line needed in the usually heavy swell of Gedney's Channel. The length taken up by the largest is:

	Feet.
Excavator (including suction-pipe)	180
Tow-line	600
Tug	120
Total	900

In a side wind, cross-tide or cross-sea, in order to keep the excavator from sagging down outside the line of buoys, it is common for the whole tow to take up a width of 400 or 500 feet of the channel. At least four self-propelling machines could work more advantageously than the two non-self-propelling machines now at work. However, by good management on the part of the tugs, and on the part of the pilots of vessels, no collision had occurred up to July 31, although there were times when such collisions seemed inevitable.

One great trouble has been that steamers would not keep down the channel from end to end, but would run in and out of it from the southern side and eastern end across the line of buoys marking the southern side, forcing the excavators off the line, and carrying away the buoys. This has caused extra expense to the contractors and extra work for the Engineers.

SOUNDING BENCH-MARKS.

Maj. G. L. Gillespie's survey of the Lower Bay in 1884 was made in two parts, referred to different gauges, the sounding being located by sextant angles to shore points whose geographical position had been established by the United States Coast Survey, the soundings being taken by a lead-line. The soundings taken east and south of a broken line drawn from Sandy Hook to the head of the Swash Channel and thence to Coney Island were referred to mean low water as established by the Coast Survey and marked on the guage on the Engineer Dock at Sandy Hook. The soundings taken west and north of this line towards the Narrows were referred to mean low water on the gauge near Fort Wadsworth, at the Narrows, sometimes called the Fort Tompkins gauge, used by both the Engineers and by the Coast Survey. The soundings which overlapped and have been replotted as a test, show only a difference of one-tenth of a foot between the two parts of the survey, proving that the mean planes to which the soundings were referred were practically the same. In Major Gillespie's survey of 1884 mean low water on the Engineer's gauge at Sandy Hook was obtained from the Coast Survey, which gave the plane of mean low water as 21.945 feet below a bench-mark on the main light at Sandy Hook, which is described as follows:

> Copper spike, with cross in its head, driven up to its head into the wall, a few inches to the westward of the northwest angle, and 9¼ inches above the ledge, or a little above 2 feet above ground. The width of the side of the octagon at the bench-mark is 11 feet 10¼ inches, and 5 feet 5¾ inches above the bench-mark in another ledge, where the diameter of the tower is reduced.

This gave the mean low-water level on the gauge on the Engineer Dock at Sandy Hook, as then established, of 2.86 feet above zero.

During Major Gillespie's survey of 1884 tidal observations were kept up almost daily, from August 21 to November 28, which, however, gave a mean level differing from that of the Coast Survey plane, viz, 2.985 feet above the zero of the gauge, or a plane 0.125 feet above the Coast

Survey plane. The soundings shown upon Major Gillespie's maps, south and east of the line mentioned above, were all referred to the Coast Survey plane.

In order to facilitate work this year, it became necessary to have a bench-mark nearer the gauge than the main light is, and one was therefore established during the survey, described as follows:

On the corner of foundation of derrick known as derrick "spud," which is situated 510 feet east of the southeastern end of Engineer office at Sandy Hook.

The elevation of this bench-mark is 10.593 feet above mean low water at the Engineer Dock, as established by the Coast Survey, and consequently 10.468 feet above the plane of mean low water established from Major Gillespie's observations from August 21 to November 28, 1884. It is well here to remark that from the records of this office it appears that the low-water plane to which the fort at Sandy Hook is referred does not correspond with that established by the Coast Survey, but is 0.75 of a foot below it.

In conducting the work this year a gauge-reader has taken daily readings, except on Sundays, from May till July 31, on the gauge at the Engineer Dock at Sandy Hook, and a clock-gauge was also established there to take continuous observations. The gauge was read at ten-minute intervals from 7 a. m. until 6 p. m.

The soundings taken in the channel in June and July, 1886, were taken from the Engineer tug General A. A. Humphreys with a lead-line. The line was marked in feet and half feet, and its length was checked by a standard steel tape before and after use, so as to correct for stretching or shrinkage of the line. While not in use the line was kept in fresh sea-water.

In taking the soundings the line was read to the nearest half foot, and the results recorded and then reduced to mean low water on the Sandy Hook gauge.

The difficulties of taking soundings in Gedney's Channel are great, owing to the fog and haze shutting out the fixed points on the shore to which sextant angles are taken to locate the soundings, and owing to bad weather or to the strength of the Atlantic swell.

The average wave in Gedney's Channel from March to July 31, this year has been about 4 feet from crest to trough; and the excavators worked in waves up to 5 and 6 feet high from crest to trough. Except at the end of February and in the early part of March of this year there had been up to July 31 no serious storms; and during the time of dredging, there have been no storms from the south, southeast, east, or northeast, the points from which the full force of the Atlantic wave is felt in Gedney's Channel, which have been at all serious.

What small blows have come from these quarters have been too short in duration to create serious wave action; but on the other hand, during that time the testimony of my assistants and of the inspectors employed upon the work is that on only two days has there been a less sea than half a foot from crest to trough. Sometimes the ground-swell succeeding heavy weather in the Atlantic has not time to subside before the ground-swell of a new storm makes.

The two sets of soundings, taken June 24 and 26, and July 12, 19, and 20, were taken in waves averaging from 1 to 2 feet from crest to trough, and the reason for the long interval between July 12 and 19 was, that about one-third of the proposed soundings were taken July 12, and none other could be taken till July 19 on account of the swell, although the excavator could work easily in it.

There have been many complaints through the newspapers, pri
pally of steamers running aground in the main channels leading o
New York Harbor. But from the testimony of my assistant and of
inspectors in charge of the excavators, who have given special a
tion to this subject, it appears that only one steamer ran aground
these channels between March and July 31, and this was the S
Laurent. Coming up the Swash Channel, on the 16th of June, durin
heavy fog, she kept too far to the westward, and ran upon a well-kno
shoal point putting out towards the channel from the westward, wh
is over 500 feet west of the south line of the channel usually taken
steamers.

At the lower end of the Swash Channel it is necessary to make qui
a sharp turn to the northward in order to get into Gedney's Channe
and the turn from the Main Ship-Channel into Gedney's Channel is eve
shorter. More room should be given for vessels at these points.

Our experience shows that the work of dredging this channel can
accomplished by means of hydraulic excavators, though those now
use may be improved upon.

One very serious disadvantage to the work has been that the excav
tion has not been done fast enough. Sufficient plant should be put
when further work is ordered to take out not less than 100,000 cub
yards per month.

With the experience gained this season there is no doubt that su
an amount can be taken out monthly from April until November,
proper machines are built for the work. It is well known what the ne
essary form of machine is for dredging in Gedney's Channel and in t
inner channels, and what the cost of the work ought to be. Therefo
in the event of our not being able to contract the work yet remaini
to be done at reasonable rates, it would seem to be expedient for t
Government to build its own machines and to do its own work.

The act of Congress approved August 5, 1886, contains the followi
item:

> Improving New York Harbor, New York: To secure a 30-foot channel at mean l
> water at Sandy Hook entrance of the harbor, upon such a plan as the Secretary
> War may approve, $750,000.

As this covers the whole channel distance between deep water insi
New York Harbor and deep water outside the outer bar, it necessari
includes Gedney's Channel, and it is expected that a part of this a
propriation will be applied to it.

It is important that a very thorough test of the practicability
keeping Gedney's Channel open by dredging alone at a reasonable ou
lay should be made before any other method of increasing the cha
nel depth is undertaken.

The question of course is whether the annual filling there will be to
great to justify annual dredging.

This can only be determined by careful surveys made before and after the dredging is done; such surveys as the report shows have been made during the progress of the work, and these surveys will be repeated in the spring.

It is unfortunate that through the inadequacy of the machines employed a greater depth has not been gained; but this was unavoidable, for there were no hydraulic machines in the country capable of doing this work when it was first undertaken, and they, therefore, had to be built for the purpose, and they necessarily suffered from the imperfections which affect all experimental machines.

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The Gedney's Channel improvement has been conducted under the personal supervision of Assistant Engineer Maurice Kingsley, whose energy and industry in laying out the work, watching all its details, directing the action of the excavators, collecting valuable information, and making the necessary soundings and surveys under many difficulties and discouragements entitle him to the strongest commendation.

This work is in the collection district of New York. Nearest light-house, Sandy Hook Light. The nearest fort is the fort at Sandy Hook.

Amount of revenue collected at the port of New York during the year ending June 30, 1886, $132,536,402.02.

AMOUNT APPROPRIATED.

By act of July 5, 1884	$200,000 00
Amount expended to date	40,812 51

Money statement.

July 1, 1885, amount available		$168,469 35
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$27,281 86	
July 1, 1886, outstanding liabilities	27,115 37	
		54,397 23
July 1, 1886, amount available		132,072 12
Amount appropriated by act approved August 5, 1886		750,000 00
Amount available for fiscal year ending June 30, 1887		882,072 12
Amount (estimated) required for completion of existing project		6,000,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		1,000,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 10.

IMPROVEMENT OF SHEEPSHEAD BAY, NEW YORK.

Sheepshead Bay, Long Island, is a small tidal bay on the west side of Rockaway Inlet, running from it westward for 2 miles to the village of Gravesend, inside and parallel to the Coney Island Beach.

Its mouth, where it connects with Rockaway Inlet, is subject to material changes, from the making and cutting away of the beach and from the changes in the location of the shoals outside, owing to storms. Its width varies from 100 to 1,000 feet, and its depth from 2 to 10 feet at mean low water.

The first survey, with a view to its improvement, was made under direction of General John Newton, Corps of Engineers, in 1879, whose report may be found on page 400, Annual Report of the Chief of Engineers for 1879; date of original report February 7, 1879.

The project for its improvement provides for diking the channel and connecting it with Rockaway Inlet, at a cost of $100,000 (incorrectly printed in Annual Report of the Chief Engineers as $10,000). Subsequently it was proposed to connect Sheepshead Bay with Dead Horse Inlet instead of with Rockaway Inlet.

The first appropriation for this improvement was made June 14, 1880

($3,000), but General Newton, on page 515 Annual Report of the Chief of Engineers for 1880, states as follows:

> The position and even existence of this outlet will depend upon the advance of Rockaway Inlet, which is now advancing westerly at the rate af 264 feet per year.
>
> The total estimate for this improvement is about $100,000, and for this reason and the one cited above, I would respectfully recommend awaiting developments and further appropriations.

By act of March 3, 1881, $5,000 more was appropriated, making a total amount available June 30, 1881, of $8,000; but no work was done up to the close of the fiscal year.

No appropriation was made and no work was done during the fiscal year ending June 30, 1882. A survey was made during this year, which developed marked changes in the shoals westward of the mouth, and, based upon it, General Newton suggested making the outlet from Sheepshead Bay through Dead Horse Inlet instead of through Rockaway Inlet.

Two estimates of the cost of doing this were furnished, as follows:

(I.)

Cut to connect Sheepshead Bay with Dead Horse Inlet, 100 feet wide, 6 feet deep at mean low water; 52,000 cubic yards, at 35 cents	$18,200
1,200 feet of creosoted diking to sustain bend in cut, at $6	7,200
7,500 feet of creosoted diking for interior channels, at $5	37,500
Total of first estimate	62,900

(II.)

Cut to connect Sheepshead Bay with Dead Horse Inlet, 100 feet wide, to 6 feet deep at mean low water; 52,000 cubic yards, at 35 cents	18,200
Dredging interior channel; 40,000 cubic yards, at 40 cents	16,000
Total of second estimate	34,200

By act of August 2, 1882, $3,000 was appropriated, making a total amount available of $11,000, less about $650 spent on surveys.

On the 22d of September, 1882, a contract, at 45 cents per cubic yard, was awarded to H. N. and A. J. Beardsley for dredging the proposed new channel into Dead Horse Inlet, but the property-owners represented that the present outlet was sufficient, and that it would be of more benefit to increase the depth in the inner bay. After a good deal of correspondence, it was decided to make the cut to Dead Horse Inlet a little to the northward of the cut originally laid out. It was to be 40 feet wide and 5 feet deep at mean low water.

The contract was commenced November 5, 1883, and was completed December 22, 1883. Twenty thousand yards were excavated and placed on the northern side of the cut, behind a bulkhead built along the line of the cut, at the cost, jointly, of the property-holders and the contractor.

On the 5th of July, 1884, a further appropriation was made of $5,000, and sealed proposals were opened September 15, 1884, for continuing the dredging in the cut and widening it to 100 feet, with a depth of 6 feet at mean low water.

The contract was let to the Atlantic Dredging Company, the lowest bidder, at 13½ cents per cubic yard.

Work under this contract was begun August 29, 1885, and continued until January 13, 1886, in which time 21,256 cubic yards of material had been excavated, increasing the total width of the cut to nearly 100 feet.

A recent examination shows that the last cut holds its depth well; but that the northern 40 feet of width has shoaled from .05 to 2 feet.

The direct passage into Rockaway Inlet has opened again during the winter, and it is probable that if this is not kept closed there will not be enough tide through the new inlet to keep it open, as the natural scour is through the old channel.

The $5,000 appropriated August 5, 1886, will be applied probably to dredging the north side of the new channel to a depth of 5 feet, and also to dredging off the points of two small bars which have formed at each end of the cut, and if this does not exhaust the appropriation the remainder may be applied to closing the old channel by diking.

There appears to have been some error in the statistics of Sheepshead Bay, furnished by one of its residents in 1884, and upon which statements of the amount of commerce likely to be benefited by its improvement have been based.

Inquiry made during the present season shows that the place has no commerce, and that the large amounts of material reported as belonging to the commerce of the place, if brought there at all, was brought for the construction and use of hotels and private residences, by rail and by wagon, from Brooklyn, and that the bay was not and could not be used for this purpose on account of its shallowness.

The vessels and boats which make use of this harbor draw less than 4 feet of water, for which the present channel is amply sufficient.

The question of the improvement of the inner bay is purely a local one, as its object is to improve the boating facilities of the bay which lies inside of Coney Island, for the benefit of Gravesend and the large hotels on Coney Island.

There appears to be no necessity at present for making further appropriations for this bay.

APPROPRIATIONS.

Date.	Application.	Amount.
June 14, 1880	Dredging	$3,000
Mar. 3, 1881	do	5,000
Aug. 2, 1882	do	3,000
July 5, 1884	do	5,000
Aug. 5, 1886		5,000
	Total	21,000

Amount expended to June 30, 1886, $15,716.27.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fort Tompkins Light. Nearest fort, Fort Hamilton. Amount of revenue collected at the port of New York during the fiscal year ending June 30, 1886, $132,536,402.02.

ESTIMATE.

Original estimate of 1879	$100,000
Revised estimates of 1882	62,900
Revised estimates of 1882	34,200

Money statement.

July 1, 1885, amount available	$4,967 83
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,684 10
July 1, 1886, amount available	283 73
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,283 73
Amount (estimated) required for completion of existing project	13,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E II.

IMPROVEMENT OF CANARSIE BAY, NEW YORK.

Canarsie Bay is the name given to a shoal tidal bay forming the northwestern part of Jamaica Bay on the south side of Long Island, whose waters flow into the Atlantic Ocean through Rockaway Inlet.

Canarsie is practically an eastern suburb of the city of Brooklyn, and the terminus of the Brooklyn, Rockaway and Jamaica Bay Railroad. From Canarsie, during the summer months, two boats make trips to Rockaway Beach.

The first survey of it by the United States Government, with a view to its improvement, was made under direction of General (then Col.) John Newton, Corps of Engineers, in 1879, and the results may be found in Annual Report of the Chief of Engineers for 1879, page 400.

The scheme of improvement, proposed in the report, is briefly to make a navigable channel from the shore at Canarsie Landing to the good navigable channel in Jamaica Bay, a distance of about 3,500 feet.

The depth of this channel was to be 6 feet at mean low water, which was to be obtained by contracting it by means of two pile-dikes, 8 feet wide, filled in with stone, as it was not believed that dredged channels would remain permanently open. The estimated cost of this project was $88,000. The rise and fall of tide here is 4.7 feet, and the low-water depth is 4.5 feet.

The first appropriation for the work was that of June 14, 1880, $10,000; and a contract was let November 11, 1880, to Henry Du Bois & Sons, for the construction of the outer 1,000 feet of the north dike, from the deep channel in Jamaica Bay towards Canarsie Landing. This contract was completed June 27, 1881, and it was proposed to apply further appropriations to the construction of the south dike, which, commencing close to the outer end of the north dike, was to run up to Canarsie landing. This was designed to be of sheet-piling, strongly braced, the estimated cost being $14,000.

By act of March 3, 1881, the sum of 5,000 was appropriated, but it was not deemed sufficient to commence the dike, and therefore it was not expended during the fiscal year ending June 30, 1882.

By act of August 2, 1882, $3,000 was appropriated, which brought the available balance up to over $8,000, which was not enough to justify beginning the diking; and in view of the little chance of sufficient funds for this purpose being soon appropriated, it was deemed advisable to apply the available funds to dredging; proposals for this work were therefore called for, and were opened September 22, 1882, and the work was let to the lowest bidder, Elijah Brainard, at 48 cents per cubic yard.

This contract was not begun till February 8, 1883, and it was finished March 31, 1883, during which time 9,726 cubic yards were removed from the channel, giving a channel 6 feet deep at mean low water, and from 50 to 75 feet wide, from the outer end of the dike to the Canarsie Landing. Narrow cuts were also made at the wharf, and the outer end of the dike was protected by building and sinking a crib 15 feet square.

No work was done during the fiscal year ending June 30, 1884.

By act of July 5, 1884, the sum of $5,000 was appropriated for this work, under which a contract was let to Henry Du Bois & Sons, September 17, 1884, for continuing the dredging at 35 cents per cubic yard, and for extending the north dike eastward 50 feet, at $29.37 per linear foot. Work under this contract was begun October 9, and was completed

November 6, 1884, during which time the proposed eastern extension of 50 feet of dike was completed, and 7,535 cubic yards of material were removed from the channel. At the close of the contract the channel was 125 feet wide at the outer end and 50 feet at the Canarsie Landing.

On page 739, Annual Report of the Chief of Engineers for 1885, Part I, Colonel Gillespie, then in charge, makes the recommendation that $25,000 be appropriated for the continuation of the improvement, to be applied to the construction of 300 feet of the south dike, to the extension eastward of the north dike 250 feet, and to the widening to 100 feet of the western end of the channel towards Canarsie Landing.

No funds have been available nor has any work been done during the fiscal year ending June 30, 1886; $10,000 was appropriated by act of August 5, 1886.

A recent examination shows that a material change has taken place in the channel, and that it might be well to modify the last project.

A shoal constituting a serious obstruction has been formed from northeast to southwest across the head of the north dike, which throws the ebb current directly across to the head of a sand island on the south side of the channel. The head and north side of this island have been cut away, and a sand point, extending out towards the north dike, has formed a bar across the channel about two-thirds of the way down the dike. On both of these bars there is 4.5 feet at mean low water; but on account of the short turns, the channels through them are only available for a 4-foot draught. It is reported that both of these bars formed this spring when the ice was running.

The current from that part of Jamaica Bay which lies north and northeast of Canarsie crosses the channel to Canarise at right angles, and this channel cannot be expected to remain open unless the current is deflected along its axis by means of diking such as was originally proposed by General Newton. Every year until that is done there will be more or less shoaling, and especially around the head and foot of the north dike.

From all accounts the running ice on the ebb is very heavy at times in Jamaica Bay, and it is an open question if sheet-piling would withstand it. It might be better, therefore, to substitute a pile dike 5 feet wide, which could be built for from $5 to $8 per foot if creosoted timber is not used. The teredo can have little effect in the shoal brackish waters of Jamaica Bay, and it is worth while trying uncreosoted piles.

The $10,000 appropriated by act of August 5, 1886, will therefore be applied to the construction of the southern dike, to be built of two rows of piles, not creosoted, 5 feet apart, the space between them to be filled with stone.

Canarsie, apart from being the terminus of the Brooklyn, Rockaway and Jamaica Bay Railroad, from which people transship by steamer to Rockaway Beach, has a large fishing industry.

Jamaica Bay is most favorable for oyster culture, and most of the oysters are sent to New York by boat or by wagon from Canarsie. It is stated that 500,000 bushels of oysters, 10,000 bushels of clams, and $10,000 worth of blue-fish are shipped from there annually, and that there are over 200 vessels and open boats engaged in the trade, drawing from 1 to 5 feet water.

Two steamers make six trips a day from Canarsie to Rockaway during the summer, each drawing about 4 feet water; and the Edith Peck makes four or five trips a day the year round to Barren Island, her draught being nearly 4 feet.

As a northwesterly wind often makes a fall of level in the bay of from 1 to 1.5 feet below mean low water, it would seem that 6 feet at mean low water at least should be maintained in the improved channel.

Original estimate for dikes of creosoted timber, $88,000.

AMOUNTS APPROPRIATED.

Date.	Application.	Amount.
June 14, 1880	Diking	$10,000
March 3, 1881	Dredging	5,000
August 2, 1882	do	3,000
July 5, 1885	Dredging and diking	5,000
Total		23,000

Amount expended, $22,800.89.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fort Tompkins Light. Nearest fort, Fort Hamilton. Amount of revenue collected at the port of New York for the fiscal year ending June 30, 1886, $132,536,402.02.

Money statement.

July 1, 1885, amount available	$486 74
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	287 63
July 1, 1886, amount available	199 11
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,199 11
Amount (estimated) required for completion of existing project	55,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 12.

IMPROVEMENT OF SUMPAWANUS INLET, NEW YORK.

Sumpawanus Inlet, known originally and on the Coast Survey charts as Sumpwams Creek, is a small creek on the south side of Long Island, emptying into the Great South Bay, near Babylon.

It lies about 36 miles east of New York City, 15 miles east of the western end of Great South Bay, and nearly double as much from the eastern end.

Fire Island Inlet, through which most of the waters of Great South Bay pass into the Atlantic Ocean, lies south-southeast about 6 miles direct, but 11 miles by the channel.

The inlet is a tidal creek, from 100 to 200 feet wide, running up to the town of Babylon, Long Island, which is situated 1 mile north of the mouth. It is crossed there by a dam, which forms a reservoir for the fresh water of a small creek which supplies the town with water.

The mean rise and fall of tides at the mouth of the inlet is only 1.3 feet, and the bottom of the bay and of the inlet is soft mud.

The first survey of Sumpawanus Creek was ordered by act of Congress approved June 14, 1880; and was made during the fall of 1880 under direction of General (then Col.) John Newton, Corps of Engineers. His report may be found on page 653, Annual Report of the Chief of Engineers for 1881, Part I.

The project based upon this survey, was briefly to dredge a channel 150 feet wide and 5 feet deep, at mean low water, from the 5-foot curve in the bay to the steamboat dock at the mouth of the creek, a distance of about 1,500 feet, and thence 5 feet deep and 100 feet wide up the inlet to the town of Babylon, a distance of about 3,500 feet. The estimated cost of the improvement was $23,115.

The mean range of tides at the mouth of the inlet being only 1.3 feet, there was practically no scour. The depth of water in the proposed channel at the time of the survey was from 1 to 3 feet in the inlet, and from 3 to 5 feet outside.

It was not believed that diking would assist this improvement; and inquiry showed that the depth of water both outside and inside the inlet had materially diminished in late years.

By act of Congress approved March 3, 1881, $5,000 was appropriated for this improvement; but nothing was done during the years ending June 30, 1881, and June 30, 1882, because the amount was too small to warrant beginning the work.

By act of August 2, 1882, a further sum of $2,000 was appropriated; and proposals were called for and were opened September 22, 1882, for dredging outside the mouth of the inlet.

John McDermott was the lowest bidder, at 69 cents per cubic yard, and a contract for the work was entered into with him. Work was begun April 9, 1883, and was closed May 17, 1883, during which time 9,481 cubic yards of material had been removed.

This gave a channel not less than 75 feet wide and 5 feet deep up to the steamboat wharf, from a point 750 feet outside of and southeast of it, and single cuts 25 feet wide were made to the northeast and west sides of the wharf, in order to facilitate the landing of steamboats.

The estimated cost of dredging in the original project was 30 cents per cubic yard; but Colonel Gillespie, in his annual report for 1883, Part I, page 568, of the Annual Report of the Chief of Engineers, estimates that the future dredging would not cost less than 50 cents per cubic yard, and therefore made a modification of the original report, estimating the cost of the dredging at $40,000, of which $7,000 have been appropriated.

No appropriations have been made since that of August 2, 1882, and no work has been done since the close of McDermott's contract on May 17, 1883.

A recent examination shows that the channel is in much the same condition as after the work of 1883, except that the expected shoaling spoken of by General Newton in his preliminary report is continually taking place.

The cut itself has shoaled about half a foot, and the flat outside about the same, giving about 5 feet in the dredged channel, but only 4 to 4½ feet outside, except in a small channel which has been kept open by the passing steamboats.

The commerce of Sumpawanns Creek is peculiar. Babylon, 1 mile above the mouth of the inlet, is a small town of 3,000 to 5,000 inhabitants, and depends almost entirely upon the summer trade of the hotels and cottages along the north shore of Great South Bay, and upon the hotels on Fire Island Beach.

To Fire Island Beach, in summer, three steamers run daily, drawing from 4 to 5 feet of water.

The actual commerce of Babylon by water has been decreasing from all accounts; for the reason, first, that the Long Island Railroad has taken away the sea-going business; and second, that the depth of water has decreased too much for sea-going vessels, even of light draught, to enter. Babylon itself has improved immensely, and has become a fashionable summer resort. At present the commerce of Babylon is carried on by three steamboats, drawing from 4 to 5 feet, running in summer to Fire Island Beach; three schooners, drawing from 5 to 5½ feet, bringing brick, lime, lumber, and other heavy freight to Babylon the year round; one hundred sloops and pleasure boats, drawing from 1 to 2 feet of water, taking out sailing and fishing parties during the summer; of which seven or eight remain in use during the winter fishing and taking oysters and clams to Patchogue, Sayville, and New York.

No oysters are brought to Babylon from the bay, and only a few clams in the summer for home consumption.

No statement of commerce appears in the annual reports, except in two letters dated May 16, 1883 (presumably), one furnished by a gentleman of the name of Sammis from Patchogue, who has large interests in Babylon; and another furnished by the United States inspector at that time, who has evidently made the mistake of including the whole commerce of the Great South Bay in the commerce of Sumpawanus Creek and Babylon.

The commerce of the creek, in my judgment, only warrants the dredging of a 5-foot channel from the 5-foot curve in the bay to the steamboat wharf for the use of the steamers, and so that the few schooners which come in can come up to the wharf without the expense of lighterage.

So far as the extension of the improvement from the steamboat dock up the inlet is concerned, I see no reason to continue it.

From all accounts the shoals in the bay kill the sea so entirely that the pleasure boats can lie in the mouth of the creek in all weathers, and the freighting interest is too small to warrant the cost of the improvement.

The original estimate of the work was $23,115.

The modified estimate is $40,000, of which $7,000 has been appropriated. $10,000 can be profitably expended in giving a 5-foot channel out into the bay for the use of steamboats, but I think that the work is more a matter of private interest than work that should be undertaken by the Government.

Revised estimate for dredging channel, $40,000.

AMOUNTS APPROPRIATED.

Date.	Application.	Amount.
Mar. 3, 1881	Dredging	$5,000
Aug. 2, 1882	Dredging	2,000
		7,000

Amount expended	$6,918 12

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fire Island Light; nearest fort, Fort Hamilton. Amount of revenue collected at the port of New York during the fiscal year ending June 30, 1886, $132,536,402.02.

Money statement.

July 1, 1885, amount available	$106 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	25 05
July 1, 1886, amount available	81 88
Amount available for fiscal year ending June 30, 1887	81 88
Amount (estimated) required for completion of existing project	33,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 13.

IMPROVEMENT OF THE MANASQUAN RIVER, NEW JERSEY.

The Manasquan River, New Jersey, empties into the Atlantic Ocean midway between Sandy Hook and Barnegat Inlet, which are about 50 miles apart.

For the first 3 miles up from the mouth it consists of a tidal estuary about one-third of a mile in width. For the next 2 miles it contracts to a width of from 100 to 150 feet; above this it opens out into a second basin 2 miles long and one-fourth mile in width. The depth of the lower basin is from 4 to 5 feet; the depth of the upper basin is from 3 to 4 feet at mean low water. The mean rise and fall of tide in the lower basin, near the mouth, is said to be about 2 feet, and at the head of the upper basin is zero, in ordinary weather.

The Manasquan, with its tributaries, drains an area of over 80 square miles.

The mouth has been, and is still, obstructed by movable bars and shoals of shifting sand, which are influenced by heavy storms.

The depth of water on these bars has varied in the last eight years from 1 to 4 feet at mean low water. Once during that time, after a heavy storm, the outlet was entirely closed.

The first survey of this river, with a view to its improvement, was made by Captain Ludlow, in 1878, under direction of Col. J. N. Macomb, Corps of Engineers, the report on which may be found on page 463 of the Annual Report of the Chief of Engineers for 1879, Part I.

The commerce of the river at that time was practically nothing, but it was expected to increase if a stable outlet could be procured by artificial means, and it was also expected that it would be used as a harbor of refuge for small coasting and fishing vessels when they were prevented by storms from making a safe harbor at Sandy Hook or Barnegat Inlet.

It was proposed to make a straight cut from the river into the ocean across the bar at the mouth, the cut to be about 200 feet wide and not less than 6 feet deep at mean low water and to be protected by parallel jetties, and a basin was to be dredged inside the jetties about 2,000 feet long, 200 feet wide, and 5 feet deep. The jetties were each to be built of two rows of piles, creosoted, and the spaces between the piles were to be filled with stone. Twelve thousand dollars was also to be expended for the removal of wrecks and snags. The total estimated cost of the project was $52,120.

This project was referred for discussion to the Board of Engineers for Fortifications and River and Harbor Improvements. Their report may be found on page 548 of Report of the Chief of Engineers for 1880, Part I.

Briefly, they reported that the project was insufficient to secure any permanent results; that the jetties, instead of being carried out to the shore-line, would have at least to be carried out to the 2-fathom curve; that they would have to be of a more stable form of construction; and that, at a rough estimate, the total cost of the improvement required to give a harbor of refuge such as Colonel Macomb proposed would be from $200,000 to $260,000. Their conclusions are as follows:

> The Board are of the opinion that the piers, as recommended in the project submitted, will not avail to keep open a good entrance from the seaward; that the piers will require further extension at great cost; and that the passage of vessels through such a long narrow outer entrance to reach the inner harbor, even if the depth be sufficient, will not be safe during a heavy storm.
>
> The inner harbor, for which an estimate for deepening has been submitted by the local engineer, may require some works of contraction to preserve its depth.
>
> The cost, however, will probably be small, and has not been considered for want of the requisite data.
>
> The Board are by no means satisfied that the uses to which the harbor, improved as in the project, could be put would prove of much public benefit.
>
> A harbor of refuge is probably needed along this coast, but it should be sufficiently deep and spacious to admit the larger classes of coasting vessels. Such harbor could be constructed only upon a plan modified considerably from the one presented, and at much greater cost.

As, however, $12,000 had been appropriated by the act approved March 3, 1879, the Board were of the opinion that Colonel Macomb's project, with certain modifications of construction, should be carried out, with a view only to straightening the channel at the mouth through the sand-bar, which then ran across it from the south beach.

Bids were accordingly opened, after due advertisement, and a contract was entered into with C. F. Drake, April 18, 1879, for beginning the construction of the dikes. The contractor failed to commence operations, the contract was annulled, and no work was done that year.

On the 14th of June, 1880, an additional appropriation of $20,000 was made; and, under date of June 9, 1880, the question of the improvement of Manasquan River was referred to Lieut. Col. N. Michler, Corps of Engineers, who had relieved Colonel Macomb, for report. The report may be found on page 712, Annual Report of Chief of Engineers for 1881, Part I.

Colonel Michler's report emphasizes that of the Board of Engineers, and states besides—

> That since this subject was first discussed the facilities of communication and transportation to and from the valley have been very much increased within the last few months; in fact, all difficulties removed by the extension of the Long Branch Division of the Jersey Central Railroad to and across the Manasquan River as far as Point Pleasant.
>
> The road crosses the river over a pile bridge about 1 mile above its mouth. The construction of this road obviates to a great degree the necessity for the proposed improvement, as now the lack of communication is supplied.

He also stated it to be his opinion that, if a harbor of refuge were necessary at that point, it could not be constructed without great expense, not at all proportionate to its utility or importance.

Further, that, "should it be decided to attempt some plan and prosecute it towards its completion, the general lines of dikes as proposed by Colonel Macomb, as described in his report and in that of the Board of Engineers, might be successfully adopted," with certain modifications of construction; but that there was every chance of a storm demolishing the whole structure, or of a single gale changing the entire nature and position of the inlet under discussion; so that no safe estimate could be made of the probable final cost.

Colonel Michler's project was approved by the Chief of Engineers, and, after due advertisement, a contract was let for the construction of the north jetty to Henry Du Bois & Son; but, owing to the lateness of the season, work was not begun until June 17, 1881.

Work on the construction of the north jetty was continued from that date up to March 8, 1882, when the contract was closed. The total length of the jetty, when the contract was closed, was 1,515 feet.

This jetty, starting from a point of salt marsh, known as Stump Point, and running in a general southeasterly direction, closed entirely the old outlet of 1879 to the northward, and turned the current of the river almost directly along its inner side of the jetty seaward. The scour on the inner side of the jetty, near the outer end, necessitated its reinforcement by a crib 130 feet long, and the whole line of diking was protected by fascine mats, and riprap on the river face, and bags of sand on the inner side.

Spur-dams of plank, fascines, and sand-bags were also built at right angles to the line of the dike on the north side to arrest the sand, and relieve the dike from the pressure produced by the emptying and filling of the tidal reservoir above.

Upon the completion of the work, the depth of the water on the outer bar was approximately 4 feet at low water, and the channel was parallel with the axis of the dike.

A sum of $40,000 was estimated as necessary for extending the north jetty 255 feet seaward, to its full projected extent, and to build 905 feet of jetty on the south side.

A sketch of the condition of the improvement June 30, 1882, with details of the construction of the jetty, may be found opposite page 702, Annual Report of the Chief of Engineers for 1882, Part I.

On the 2d of August, 1882, a further sum of $7,000 was appropriated for the improvement; making the total available, including the balance of the old appropriation $8,500.

A contract was let in October, 1882, to Stephen A. Kelly for the construction of part of the south jetty. Operations were begun under this contract in November, 1882, and were closed June 30, 1883, during which time 475 feet of the jetty had been completed.

The outer end of the south jetty starts at a point 100 feet inside the outer end of the north jetty, and 200 feet from it to the southward. For the first 100 feet inward it is parallel to the north jetty; but the inner end of the second 100 feet is 240 feet from the north jetty; the remaining 275 feet inwards is thrown back from the channel to the southward, so as to prevent the cutting of the beach behind the jetty, and deflect the current towards the center of the channel. The outer 200 feet of this jetty is formed by two rows of piles sawed off at 1 foot above mean high water, set 12 feet apart from "inside to outside," the space between being filled with stone. Over the remaining 275 feet the jetty is only 5 feet wide.

It was reported, at the close of the year 1883, that the condition of the improvement was satisfactory, and the extension of the north jetty 500 feet seaward, and the south jetty 300 feet seaward and 300 feet shoreward, was recommended, the estimated cost of which was $33,000.

No appropriation has been made, and no work has been done since June 30, 1883.

In 1884 it was reported that there had not been less than from 2½ to 3 feet at mean low water on the bar since the construction of the jetties, but that a shoal inside them, starting from the inner end of the north jetty, was making rapidly to the southward, throwing the currents at half-tide towards the south side of the channel, which resulted in cutting round back of the inner end of the south jetty; and to prevent a breach from being made in the beach back of the south jetty, an appropriation of $30,000 was urged for extending the south jetty shoreward 300 feet, and for repairing it; for extending the north jetty 300 feet seaward; and for dredging part of the shoal putting out from the inner end of the north jetty.

In 1885 an examination showed that there was a depth over the bar of 3 feet at mean low water, that the shoal at the inner end of the north jetty had materially increased to the southward, and consequently that the deep-water channel had been still further thrown forward towards the south bank, and an appropriation of $25,000 was asked for to extend both jetties seaward 300 feet, to extend the south jetty shoreward 100 feet, and to dredge the inner shoal so as to bring the channel more in a line with the axis of the jetties.

No money has been available and no work has been done during the fiscal year ending June 30, 1886.

A recent examination, however, shows the condition of the improvement to be very unsatisfactory, and proves conclusively the correctness of the opinions of the Board of Engineers in 1879, and of Colonel Michler in 1880, mentioned above; and also had sufficient money been appropriated for the extension of the shore-arm of the south jetty, asked for in 1884, that many of the present bad features might have been averted.

The beach has made out on the north side of the north jetty till the mean high-water mark is only 20 feet inside it, and the high-water shore-line on the south side has made past the outer end of the south jetty, as originally predicted by the Board of Engineers.

Across the mouth, and distant about 200 feet seaward of the outer end of the north jetty, is a bar parallel with the beach, a-wash at low water, extending some 500 feet north of the north jetty, and 200 feet south of the south jetty. Between it and the shore-line there is a channel around the north and south ends of the shoal with about 2 feet of water over it at mean low water.

The shoal putting out southward from the shore end of the north jetty has increased till at mean low water it is bare within about 30 feet of the inner end of the south jetty; and the larger part of it is about 2 feet out of water at low water.

This has thrown the deep-water channel over to the southward, so that the inner portion of the south pier, which is deflected over to the southward, is in the deepest water of the channel; the filling is all washed out; and the mean low-water line of the south shore runs about 150 feet inside the inner end of the jetty. A deep hole has been scoured out under this 150 feet of the inner end. The current is then deflected across the channel almost at right angles towards the north jetty; and a deep hole with from 10 to 12 feet of water scoured along its face, gradually diminishing in depth towards the outer end, to about 5 feet.

The outer end of the south jetty is covered with sand which has come over into the channel, forming a beach inside it 20 feet wide at mean low water.

The channel now from the ocean into the bay may be fairly said to be in worse condition than at the time of the survey of 1879.

The ground taken originally that Manasquan could be used as a harbor of refuge is no more tenable now than when the Board of Engineers decided against it in 1879. It has now no more commerce than in 1879, and the plea that its improvement was necessary to get local products to New York is stated to be unsound since the extension of the Long Branch Railroad. But the question comes up, shall the present works be allowed to go to ruin, and probably (if the piling and crib work begins to break away, as it undoubtedly will shortly) block up forever any ingress to or egress from the river.

By extending the shore end of the south jetty, not on the present line, but on a line nearly parallel to the norty jetty, it is reasonable to expect that the increased scour will cut a channel again through the sand bar at the inner end of the north jetty, and that the extension of both jetties seaward from 300 to 400 feet will scour out the outer bar; and that the channel, so obtained, will remain for a number of years.

It seems advisable, at all events, that an accurate survey be made of the condition of the improvement on which an estimate can be made of the cost of a modified project. The survey would cost about $300.

While not believing the improvement any more necessary to commerce than the Board of Engineers, to save the existing work I should also recommend such an appropriation as would give at least as good an entrance to the harbor as existed in 1879, unless the cost is found to be excessive.

In case it is decided to continue the improvement as a result of this survey, the whole amount of money asked for should be appropriated at once, in order to save further deterioration of the existing works and channel.

Manasquan River is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. Nearest light-house, Barnegat Light. Nearest fort, fort at Sandy Hook, New Jersey. Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, $31,067.65.

Original estimate of 1879 for jetties and dredging	$52,120
Additional estimate of 1882	19,880
Total	72,000

APPROPRIATIONS.

Date.	Application.	Amount.
March 3, 1879	North Jetty	$12,000
June 14, 1880		20,000
August 2, 1882	South Jetty	7,000
Total		39,000

Amount expended to June 30, 1886, $39,000.

Money statement.

Amount (estimated) required for completion of existing project	$33,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 14.

IMPROVEMENT OF SHREWSBURY RIVER, NEW JERSEY.

The Shrewsbury River is a large shallow estuary in north eastern New Jersey, entering the lower bay of New York at the junction of the peninsula of Sandy Hook with the mainland, about 1 mile due north from the lights on Navesink Highlands.

Its land drainage area is about 120 square miles. The lower part, running from the mouth for 3 miles up to Rocky Point, just below Seabright, is about 1,200 feet wide. For this distance it runs parallel with the coast line of the Atlantic Ocean, and is only separated from it by a sandy beach from 200 to 1,000 feet in width.

From this point it divides into two branches, one known as the South Branch, keeping more or less parallel with the beach for about 2 miles further to the southward, when it opens into a large bay called Pleasure Bay, 4 miles long and half a mile wide. The head of navigation on the South Branch is Branchport, situated on a little creek leading into the southern side of the bay. The distance from the forks to Branchport is about 6 miles.

The other fork, known as the North Fork, strikes away from the south at right angles to the westward at Rocky Point, with a width of about 1,000 feet for the first mile up to Oceanic Wharf, when it opens out into another land-locked bay called North Shrewsbury. This bay is about the same size as the one at the head of the South Fork, viz, 5 by one-half miles.

It is stated by Colonel Kurtz that in 1779 to 1782 the two branches discharged directly into the Atlantic Ocean, opposite the mouth of the North Fork, and had no outlet into Sandy Hook Bay.

Opposite the Navesink Highlands the ocean beach is narrowest, and it has often been broken through, to the detriment of the lower part of the channel. Since the construction of the New Jersey Southern Railroad along the crest of the beach, in 1865, these breaks have been less frequent and less damaging to the channel, the railroad company having strengthened the weakest part of the beach by jetties and bulkheads.

When the question of the improvement of this river came up in 1870 its mouth was closed by a bar with from 3 to 4 feet of water on it. Above this, both up the main river and up the two branches to where they enter the large bays, were shoals with from 3 to 4 feet of water on them, separated by stretches of water from 6 to 13 feet deep.

The commerce of the Shrewsbury River has never experienced any trouble in its passage through these bays, but only in the parts of the river leading out of them.

The emptying and filling of these large tidal basins create swift ebb and flood currents in the river, with shifting bars. The material is unstable sand, and appears to be especially subject to ice action in winter. The river is practically closed by ice for about four months in the year.

A bad break in the beach in 1853, which damaged the lower channel, was made the subject of a special report to the Chief of Engineers by Lieut. M. Harrison; but it was not until 1870, after the citizens had spent $2,000 in dredging, that the Federal Government took steps for the improvement of the Shrewsbury River.

In 1870 the first survey of the river was made, under direction of Lieutenant-Colonel Kurtz, Corps of Engineers, and his project for its improvement may be found in Annual Report of the Chief of Engineers for 1871, page 703. This project was, briefly, to dredge the existing shoals, at an estimated cost of $14,000.

Fourteen thousand dollars was appropriated for this purpose in 1871, and work under this project was carried on in 1871, 1872, and 1873; but it was found more expensive than had been expected, and a further sum of $5,000 was appropriated.

In 1876 a partial survey was made, and a new scheme of improvement, by diking and dredging was made, the cost being estimated at $19,000; but no money was appropriated for it, and no work done between 1873 and 1878.

In 1878 an extended survey was made by Captain Ludlow, Corps of Engineers, under direction of Col. J. N. Macomb, Corps of Engineers, and the following scheme was proposed (see Report of the Chief of Engineers for 1879, pages 405–411): It provided for obtaining, by dredging and by contracting the wider portions of the river by the use of dikes, channels 6 feet deep at mean low water and from 200 to 300 feet wide, extending from the 6-foot curve at the mouth in Sandy Hook Bay up to the 6-foot curves on both branches in the bays above. At that time the minimum depth in the channel across the bar was 2.9 feet, and above the same depths could be carried over the shoals of the upper rivers.

Two estimates of cost were submitted, one of $134,686, and another of $163,091. The report was submitted to a Board of Engineers, who, on February 7, 1879, proposed the following modification:

1. South Shrewsbury:	
Estimate, Captain Ludlow's project	$39,683
To which add cost of Dike H	8,400
	48,083
Deduct for dredging	1,000
Total for South Shrewsbury	47,083
2. North Shrewsbury:	
Estimate	39,103
Improvement of ebb-channel below Highlands	55,900
Total	142,086

In 1879 and 1880 pile and stone dikes were built at the north and south Shrewsbury branches, contracting their width, and dredging was carried on in the North Branch.

In 1880 and 1881 a dike was built at the head of the South Branch, and dredging was carried on from Seabright to Pleasure Bay, at the head of the South Branch. It was found that just above Seabright Bridge a bar of hardpan crossed the channel, which increased the expense of dredging materially.

In 1880, 1881, and 1882 a dike 4,021 feet long was built at the mouth on the east bank of the river, so as to close up Spermaceti Bay. In 1882 and 1883 dredging was done along the dike and across the bar, and also in the South Branch. Work was suspended in October, 1883, for the want of funds, and no work has been done since. At that date the condition of the improvement is stated by Colonel Gillespie, Corps of Engineers (Annual Report of the Chief of Engineers for 1885), to have been as follows:

> *From the mouth to Highlands Bridge.*—A pile-dike was built from Crane Point to opposite Cove Point at the entrance, 4,021 feet long, with widths varying from 5 to 8 feet. A channel was dredged across the bar 2,100 feet long, 75 feet wide, and 6 feet deep, mean low water, and a channel was dredged from Island Beach to Highlands Bridge 1,800 feet long, 25 to 100 feet wide, and 6 feet deep. The completion of the project for this section requires the bar and Island Beach channels to be widened to 300 feet.

North Branch.—The dike on the right bank from Lower Rocky Point to Barley Point was completed for a length of 1,885 feet, with two openings for use by small boats belonging to property-holders on the south side, and the channel at Lower Rocky Point dredged to a width of 75 feet (since increased to 200 feet by current action) giving 6 feet depth. From Barley Point to Oceanic Wharf, at Oceanic, a channel near Barley Point was dredged 1,300 feet long, 100 feet wide, and 6 feet deep. This has since shoaled to 4 feet and less; and near Oceanic Wharf a channel 600 feet long and 100 feet wide and 6 feet deep. The dike on the right bank not having been finished, frequent shoalings have occurred opposite Barley Point, requiring many dredgings over the same ground. The completion of the improvement in this reach requires the construction of 1,940 feet of diking on the right bank below Barley Point, and the widening of the channel at and above Barley Point to 150 feet.

South Branch.—The dike on the left bank connecting with that on North Branch, 1,856 feet, was built, and a channel from entrance to Bellevue Dock 2,000 feet long, 100 feet wide and 6 feet deep, was dredged. Immediately above Seabright Bridge a channel was blasted through rock and cemented gravel, 400 feet long, 60 feet wide, and 7 feet deep. At the entrance to Pleasure Bay the dike on the left bank springing from Gunning Island, 1,513 feet long, and that on the right bank of Sedge Island, 503 feet long, were built, and the channel between them, 3,500 feet long, 150 feet wide, and 6 feet deep, was dredged. The completion of the project requires the channel from the entrance to Bellevue to be widened to 300 feet. The South Branch is quite wide at the junction of the North Branch and is so subject to shoaling that resort must be had every few years to the dredge. Almost two years have now elapsed since the work of improvement was suspended, and while there has been no complaint of shoal water in the main stem and in the South Branch to the interruption of navigation, a late examination shows that there has been a marked shoaling in the North Branch, opposite upper Barley Point, owing to the unobstructed flow of the tides through the interval left in Dike C, projected for the right bank of the North Branch. (See chart, page 698, Annual Report of the Chief of Engineers, 1881, Part I.)

The shoal which has formed at upper Barley Point has barely 3¼ feet over it at mean low water, and in order to get relief from this obstruction the owners of the steamboats plying between Red Bank and New York City have been compelled to open a channel through it at their own expense. The amount so expended is stated to be $1,400.

In the above description an accidental omission is made of 598 feet of dike built on the North Branch of the Shrewsbury on the right bank from Barley Point down-stream towards the 1,885 feet of diking built up-stream from the forks of the two branches, giving a total amount of 2,483 feet of diking built on the North Fork.

An examination made after the 30th of June, 1886, shows that there is sufficient water for the existing commerce at any stage of water, except on an exceptionally low tide, at the following points:

1. *Main river, from the mouth to the junction of the two branches at Rocky Point.*—The channel is following the dike more closely than it used to do, and a clear 6 feet at mean low water can now be found within 50 or 100 feet of it, until about 300 feet from the lower end, where only 5 feet can be carried out into the Horseshoe or Sandy Hook Bay.

The last dredging done was not carried along the lower end of the dike, but diverged from it towards the west, crossing a bar which originally put out from the shore to the westward below the end of the dike, and during the past three years this cut has gradually been filling up on the western side, but cutting out to the eastward towards the dike. It is probable if the dike were carried 300 feet further into 12 feet water that this bar would entirely disappear.

2. *North Shrewsbury.*—Five feet can be carried through an intricate channel from Rocky Point up to Oceanic Wharf; but owing to the center, 1,900 feet, of the projected dike not being finished, the whole effect of the proposed contraction is at present lost. At the last contract prices the completion of this work would cost about $10,000.

3. *South Shrewsbury.*—Four and one-half feet can be carried at mean low water through this channel; but there are two points, (1) *Bellevue Shoal* and (2) *Gunning Island*, where the channel is very narrow, and it

is almost impossible for the steamers to carry more than 4 feet through them.

The improvement of the Bellevue Shoal is simply a matter of dredging, perhaps 5,000 cubic yards, at 25 cents per yard, which would give a channel 100 feet wide and 5 feet deep.

The Gunning Island Shoal, since the dikes have been built, has been moving over from west to east, making a very inconvenient bend, and $1,000 would cut off this so as to give a fair 5-foot channel.

But before a permanent scour can be established it will be necessary to build a dike across from the lower end of Gunning Island to the mainland, so as to close entirely the old western channel and throw the whole current into the east channel.

During a recent examination of this river the owners and agents of the four steamboats plying up the two branches were seen, and the points mentioned are the only points of difficulty they spoke of.

They express their satisfaction with the past improvements, and especially with the effects of the dikes.

As the heavy freighting season is almost past, and the ice next spring will undoubtedly make changes in the channels; and as the navigation of this river has been quite satisfactory since March of this year, the channels having increased in width and depth since spring, it will be best not to undertake any other work here this fall. But, as soon as the ice breaks up in the spring, an examination of the river should be made to ascertain what changes may have taken place. The last appropriation will be applied to diking or dredging in either branch as may be found most expedient; and a further appropriation of $15,000 should be made for the completion of the North Branch Dike, and for such dredging as may be necessary, and for the construction of the Gunning Island Dike and the extension of the dike at the mouth. This would apparently be sufficient for the existing and prospective commerce of the Shrewsbury River at present.

The majority of the commerce of the Shrewsbury is carried in four steamboats, two running daily from New York up the North Branch to Red Bank, and two from New York up the South Branch to Branchport. The Sea Bird and the Albertina run up the North Branch, drawing 5 feet and 4 feet, respectively, and the City of Long Branch and Helen run up the South Fork, drawing each from 4 to 4.5 feet, according to freights.

From what could be learned the commerce had not increased very materially in the past three years, although it increased rapidly from 1879 to 1883.

The commerce, however, is sufficient to warrant the carrying out of the project as presented in this report. The mean rise and fall of tides in the Shrewsbury is 5 feet at the mouth, 3 feet at Highlands Bridge, 2 feet at Red Bank, on the North Branch; 2 feet at Seabright, on the South Branch, in Pleasure Bay, and at Branchport is 1.3 feet.

This work is in the collection district of Perth Amboy, New Jersey, which is the nearest port of entry. Nearest light-house, Navesink lights. Nearest fort, fort at Sandy Hook, N. J. Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, $31,067.65.

AMOUNTS APPROPRIATED.

Date.	Application.	Amount.
Aug. 30, 1852	Survey	$1,500
Mar. 3, 1871	Dredging } Project of 1870	14,000
Mar. 3, 1873	Dredging	5,000
	Total of old project	20,500

EXISTING PROJECT.

Date.	Application.	Amount.
June 18, 1878	Diking	$18,000
Mar. 3, 1879	......do	10,000
June 14, 1880	......do	30,000
Mar. 3, 1881	......do	86,000
Aug. 2, 1882	Dredging	30,000
	Total	174,000

Amount expended, $173,778.30.

Money statement.

July 1, 1885, amount available	$577 20
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	355 50
July 1, 1886, amount available	221 70
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,221 70
Amount (estimated) required for completion of existing project	40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 15.

IMPROVEMENT OF KEYPORT HARBOR, NEW JERSEY.

Keyport Harbor lies at the mouth of the Mattawan Creek, on the south side of Raritan Bay, 5 miles east of the mouth of the Raritan River, and 21 miles southwest of the Battery, New York Harbor. There is no real harbor or anchorage here; and at the time of the survey of this harbor, in 1872, there was an average depth of about 4 feet at mean low water in the bight leading up to the wharves.

The town of Keyport lies on the east side of the creek and harbor. In 1866 a channel 6 feet deep was dredged by private parties from the bay up to the wharves.

A survey of the harbor, by the United States Government, was made under direction of Col. John Newton, Corps of Engineers, in the fall of 1872, when four steamers drawing from 5 to 7 feet, and a number of schooners and vessels drawing up to 7 feet, were using the harbor and doing a business valued at nearly $3,000,000, the traffic being principally to and from New York.

Borings showed that the bottom of the harbor consisted of hard clay and fine sand, and that the maximum velocity of the tidal current was only half a knot per hour, which was inadequate to effect the stability of the river bottom.

The mean rise and fall of tides at Keyport is about 5 feet.

It was believed that an improvement of the channel by dredging would be permanent, and a project was made and approved for dredging a channel 200 feet wide, about 4,700 feet long, and 8 feet deep at mean low water, from the steamboat wharf out to the 8-foot curve of the bay; the estimated cost of this was $30,475. No money was appropriated for this purpose, however, until August 2, 1882, when the full estimated amount was appropriated, and a channel was dredged in 1882-'83, 5,000 feet long and 8 feet deep, from the steamboat dock to the 8-foot curve in the bay, with a uniform width of 200 feet, except in a short reach between the steamboat dock and the wharf of the New York and Freehold Railroad, where it was only 160 feet wide.

It was found between 1872 and 1882 that a material shoaling had taken place in the channel, which made it necessary to increase the original estimate, $10,000, and this was recommended by Colonel Gillespie in 1884.

There are at present three steamboats making round trips daily to New York, one having a draught of 8 feet, the other two of 6 feet.

In 1884 the value of the exports and imports had increased from $3,000,000 in 1872 to $5,650 000 and the commerce appears to be still on the increase. The improvement has been of great benefit to the port, enabling vessels to get in there at any stage of tide. The expenditure of $10,000 for completing the improvement is recommended.

This work is in the collection district of Amboy, the nearest port of entry Perth Amboy, N. J. Nearest light-house, Great Beds Light, in Raritan Bay. Nearest fort, fort at Sandy Hook, New Jersey. Amount of revenue collected at the port of Perth Perth Amboy, N. J., during the fiscal year ending June 30, 1886, $31,067.65.

Original estimate of 1873	$30,475
Additional estimate of 1884	10,000
Total	40,475

APPROPRIATIONS.

Date.	Application.	Amount.
Aug. 2, 1882	Dredging	$30,475

Amount expended to June 30, 1886, $29,523.01

Money statement.

July 1, 1885, amount available	$982 19
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	30 20
July 1, 1886, amount available	951 99
Amount available for fiscal year ending June 30, 1887	951 99
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 16.

IMPROVEMENT OF MATTAWAN CREEK, NEW JERSEY.

Mattawan, sometimes called Middletown, Creek is a small stream in New Jersey, about 5 miles long, emptying into Raritan Bay at Keyport, which lies on its east bank, at its mouth, about 5 miles east of the Raritan River. It is navigable for 2 miles from its mouth up to the Long

Branch Railroad crossing. Its width is from 100 to 150 feet. There is scarcely any land drainage into it, and it is essentially a tidal estuary.

The commerce of the creek is carried on chiefly by means of sloops and schooners of from 4 to 7 feet draught, and by one steamer drawing 5 feet, which makes daily trips in summer from New York up to the railroad bridge crossing.

Prior to its improvement the channel was obstructed by mud flats and shoals with from 2 to 3 feet of water on them. The mean rise and fall of tide is about 5 feet.

A survey of the creek was made in 1880, under act of Congress approved June 14, 1880, and a scheme of improvement was recommended (see Report of the Chief of Engineers 1881, Part I, page 721), which was as follows:

To form a channel by dredging 4 feet deep at mean low water and 100 feet wide from the mouth up to Winkson Creek, a distance of 1 mile; thence to the head of navigation at the Long Branch Railroad Bridge 4 feet at mean low water and 75 feet wide.

The estimated cost of this was, 48,000 cubic yards, at 60 cents	$28,800
Contingencies	4,320
Total	33,120

The first appropriation for this improvement was made March 3, 1881, $15,000. And in that year a contract for dredging was let to John Van Patten, at 48 cents per cubic yard, under which work was carried on up to June 28, 1882, when a channel 100 feet wide and 4 feet deep had been obtained from the mouth up to Winkson's Creek, and a channel 50 feet wide and 4 feet deep from Winkson's Creek up to the brick-yards, and thence up to the steamboat wharf at the head of navigation, one 25 feet wide and 4 feet deep. The total amount of material excavated was 25,630 cubic yards.

August 2, 1882, a further appropriation of $6,000 was made, with which the channel was increased to 60 feet in width up to a point 600 feet above the brick-yards, and to 30 feet in width up to the head of navigation; and a basin was dug opposite the steamboat landing to facilitate her turning round. The total amount removed under this contract was 8,897 cubic yards. No work has been done since this contract was closed, May 14, 1883.

Under the original estimate 13,473 cubic yards of excavation is yet required to complete the project, estimated to cost $9,000; but there appears to be no necessity for further improvements at present, though it would doubtless be a convenience, especially to the steamboat, if the greater width at first proposed were given to the upper part of the channel. The large sloops and schooners employed in the brick business are of such draught that they must go up and down at nearly high water, and the steamer is also a tidal boat. They all draw too much water to get up and down with anything less than a half-tide. I do not, therefore, recommend any further appropriation for this creek until some material shoaling takes place in it, or until the amount of its commerce increases to such an extent as to justify it.

The commerce of Mattawan Creek consists of farm produce carried to New York by the steamboat and of bricks carried from the brick-works in sloops and schooners.

Its amount and value was estimated in 1882 and 1883 to be—

14,000,000 brick	$70,000
Sundries	80,000
Total	150,000

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry; nearest light-house, Great Beds Light in Raritan Bay; nearest fort, fort at Sandy Hook, New Jersey. Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, $31,067.65. Original estimate, $33,120.

AMOUNTS APPROPRIATED.

Date.	Application.	Amount.
Mar. 31, 1881	Dredging	$15,000
Aug. 2, 1882	......do	6,000
	Total	21,000

Amount expended, $21,000.

Money statement.

Amount (estimated) required for completion of existing project........ $12,120 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 17.

IMPROVEMENT OF CHEESEQUAKES CREEK, NEW JERSEY.

Cheesequakes Creek, called Cheese Creek on the Coast Survey charts, is a small, crooked tidal stream, rising in New Jersey, and entering Raritan Bay on the south shore 2 miles east of South Amboy. Its length is a trifle over 3½ miles, and it averages about 100 feet in width. It is bounded on both sides by marsh lands, and little surface water drains into it.

Prior to the first improvement a bar had formed across the mouth, which had gradually increased into a sand bank, or beach, putting out from the east bank, and throwing the mouth a quarter of a mile to the westward through a channel parallel with the general shore-line.

At the time of the first survey, in 1879, the mouth of this opening was obstructed by a bar with only 1½ feet water on it at mean low water.

Above its mouth, up to the head of navigation at Whitehead's, 3½ miles distant, there was 4 feet water and over for three-quarters of the distance, the rest of the stream being obstructed with bars, with a depth of water of 1½ feet or more over them at mean low water.

The mean rise and fall of tide in the creek is 5.1 feet.

The commerce of the creek then (as now) consisted in exports of clay, sand, brick, wood, &c., valued at $60,000, and the imports at $50,000 per year. This was carried on in sloops and schooners drawing from 5 to 7 feet.

The first survey was ordered by act of March 3, 1879, and was made under direction of Brig. Gen. (then Col.) John Newton, Corps of Engineers, in the fall of 1879.

The report of this survey and the accompanying project may be found in the Annual Report of the Chief of Engineers for 1880, page 525, Part I.

The scheme of improvement proposed was to obtain a depth of at least 4 feet at mean low water from Raritan Bay to Whitehead's Dock, a distance of 3½ miles.

The existing mouth of the creek was to be closed by sheet piling, and a new mouth was to be formed by cutting a channel 5 feet deep through the sand-bar into the bay at right angles to the shore line. This channel was to be protected by stone jetties, with wooden substructures, placed 200 feet apart, parallel to each other, and extending out into the bay to the 5-foot curve a distance of about 1,600 feet. Above the mouth the channel was to be deepened to 4 feet by dredging, and where necessary the width was to be contracted by pile revetments.

The estimated cost of this was as follows:

Locality.	Object.	Amount.
At mouth of creek	3,000 linear feet of timber foundation for jetties, at $4	$12,000
	10,000 cubic yards of stone in jetties, at $1.75	17,500
	50,000 cubic yards of dredging between jetties, at 16 cents.	8,000
	550 linear feet of pile-dike, at $6	3,300
Cut from New Landing to Forman's Dock.	6,000 cubic yards of dredging, at 27 cents	1,620
	32,000 cubic yards of dredging, at 16 cents	5,120
	1,000 linear feet of pile-dike, at $6	6,000
Cut above Forman's Dock	4,000 cubic yards of dredging, at 27 cents	1,080
	23,000 cubic yards of dredging, at 16 cents	3,680
	300 linear feet of pile-dike, at $6	1,800
Deepening channel to Whitehead's Dock.	11,000 cubic yards of dredging, at 16 cents	1,760
At mouth of creek	200 linear feet of pile-dike, at $6	1,200
Deepening channel of Stump Creek	15,000 cubic yards of dredging, at 16 cents	2,400
	Engineering and contingencies, 15 per cent	9,819
	Total cost of improvement	75,279

The first appropriation made for the improvement of the creek under this project was that of June 14, 1880, $20,000; but no work was done during the fiscal years ending June 30, 1880, and June 30, 1881. March 3, 1881, a further sum of $5,000 was appropriated; and bids were asked for and opened July 31, 1881, for dredging the new outlet, closing the old outlet, and the partial construction of jetties at the mouth, but the prices bid were deemed too high, and it was finally decided to wait for a further appropriation before beginning work. No work was therefore done during the fiscal year ending June 30, 1882.

The act of August 2, 1882, appropriated the sum of $15,000; making the total amount available for this improvement nearly $40,000.

Proposals were therefore invited by public advertisement, and opened September 22, 1882, for dredging the new channel, building the jetties, and for closing the old channel by sheet-piling.

The lowest bidder was Samuel R. Cummings; and his bid being thought reasonable, a contract with him was entered into upon the approval of the Secretary of War.

Work under this contract was begun in December, 1882, and was continued up to November 6, 1883, with the following results:

The eastern jetty was completed for a distance of 925 feet, the western for a distance of 995 feet. A channel 1,600 feet long was dredged through the sand-bar for a width of 200 feet, with a depth of 5 feet at mean low water, in the middle 100 feet of it. This dredging extended about 500 feet beyond the outer end of the jetties to the 5-foot curve in Raritan Bay, and extended up to the 5-foot curve in the creek.

The old opening of the creek to the westward was closed with a sheet-pile revetment 532 feet in length. The changing of the course of this outlet necessitated the county putting in a new bridge and rebuilding the turnpike. The above work exhausted the appropriation, with the exception of a small amount, which was spent in the spring of 1884 in

repairing the sheet-piling, which was damaged by high water in a heavy northeasterly gale.

No appropriations have been made since, and no further work has been done there.

The condition of the improvement in the summer of 1886 was very satisfactory. The sheet-piling and jetties needed no repairs, and the channel between the jetties had only shoaled about 6 inches, giving 4.5 of water instead of 5 feet in two places, one at the upper end and one just outside them.

It seems a difficult matter to arrive at the actual commerce of the creek. Persons living upon it have since 1879 variously estimated its value from $110,000 to $216,000 per year, while the tonnage appears from their statements to be about 50,000 tons per year. At all events the improvement, while being a great help to the commerce of the creek, has not materially increased it.

In the Annual Report of the Chief of Engineers for 1885, page 744, Part I, it is stated that the facilities for navigation in 1885 were ample for the commerce of the creek.

I fully concur in this statement, and therefore do not recommend any further appropriation at present.

This work is in the collection district of Amboy, N. J. Nearest port of entry, Perth Amboy, N. J. Nearest light-house, Great Beds Light in Raritan Bay. Nearest fort, fort at Sandy Hook, New Jersey. Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, $31,067.65.

Original estimate for dredging, diking, and jetties	**$75,279 00**
Revised estimate for dredging, diking, and jetties (1885)	**90,000 00**

APPROPRIATIONS.

Date.	Application.	Amount.
June 14, 1880. Mar. 3, 1881	Dredging, jetties, and timber bulkhead	$20,000 5,000
Aug. 2, 1882	do	15,000
		40,000

Amount expended, $40,000.

Money statement.

July 1, 1885, amount available	$1 52
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1 52
Amount (estimated) required for completion of existing project	50,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 18.

IMPROVEMENT OF RARITAN BAY, NEW JERSEY.

Raritan Bay forms the western part of the large triangular bay inclosed between Sandy Hook, the New Jersey shore, and Staten Island, the eastern part of which is commonly known to New Yorkers as the Lower Bay, as it lies just outside of or below New York Harbor, which is the name given to the inner body of water on which the city of New York is situated.

The Raritan River flows into it at its extreme western end, passing between Perth Amboy and South Amboy, and it is connected with Newark Bay by the Arthur Kill, or Staten Island Sound, which separates Staten Island, which belongs to the State of New York, from the New Jersey shore, and joins Raritan Bay at Perth Amboy.

The bay varies in depth from 30 to 5 feet, decreasing gradually towards its western and southern sides.

The natural channel leading out of it, after passing the Great Beds Light, at the junction of Staten Island Sound and the Raritan River, does not follow the middle of the bay, but hugs the Staten Island shore for about 4 miles to Seguine Point, situated about half a mile east of Prince's Bay Light; thence it runs southeastwardly towards the inner point of Sandy Hook for about 2 miles, crossing a shoal which puts out from the Staten Island shore to the southward.

Previous to the survey made by the Government in 1880, 18 feet at mean low water could be carried from Perth Amboy to Great Beds Light in the channel, while there was not less than 21 feet of water from Great Beds Light to Seguine Point; but from Seguine Point to deep water in the outer bay only 14½ feet of water could be carried across the shoal.

The width of this shoal between the 21-foot curves was about 8,000 feet.

Through the middle of the bay south of this channel, that is, from Great Beds Light directly towards Sandy Hook, only 11 feet water could be carried over the shoals.

The above depths all refer to mean low water.

A survey of this bay was ordered in 1880 with the view of ascertaining the practicability of securing a greater depth of water from the main ship channel in the lower bay to the wharves at Perth Amboy, as vessels were often much delayed in crossing the shoal east of Seguine Point.

This survey was made under direction of Lieutenant-Colonel Michler, Corps of Engineers, in 1880, whose report may be found in the Annual Report of the Chief of Engineers for 1881, Part I, pages 717 to 719.

This report recommended dredging a channel 300 feet wide and 21 feet deep at mean low water, from Seguine Point southeastward to the deeper waters of the bay outside, requiring the removal of—

460,000 cubic yards of material, at 25 cents	$115,000
Contingencies	11,500
Total estimated cost	126,500

Owing to the diminution of the velocity of the ebb current after leaving Seguine Point and to its unfavorable direction, as it crosses the proposed channel at an angle of about 45°, it was not expected that the dredged channel would remain permanently open; but as no other means of obtaining a permanent channel, by diking, &c., was deemed practicable, the project was decided on and approved.

The mean rise and fall of the tide is the same in Raritan Bay as at Sandy Hook, namely, 4.8 feet.

The first appropriation made for this project was that of March 3, 1881, $50,000.

Under it the work of dredging was let to the Atlantic Dredging Company in 1881, at 28 cents per cubic yard, and operations were commenced in October, 1881, and continued to June 17, 1882, in which time 166,346 cubic yards had been excavated, giving a channel through the shoals 21 feet deep and 105 feet wide.

Under date of August 2, 1882, a further appropriation of $50,000 was made.

The contract was again awarded to the Atlantic Dredging Company in the fall of 1882, at 22 cents per cubic yard, under which work was carried on up till October 31, 1883, in which time 202,226 cubic yards were excavated, which increased the width of the channel to 240 feet, except at the western end, where, for 2,000 feet, it only had a width of 200 feet.

By act of July 5, 1884, $20,000 was appropriated for this work. The Atlantic Dredging Company was again the successful bidder, and a contract was entered into with it at 16 cents per cubic yard. This contract was closed December 13, 1884; under it 112,657 cubic yards of material were excavated, of which 2,403 cubic yards were not dumped where required and were therefore not paid for.

The total amounts appropriated to June 30, 1884, amounted to—

Act of March 31, 1881	$50,000
Act of August 2, 1882	50,000
Act of July 5, 1884	20,000
Total	120,000

With this amount, a total of 481,329 cubic yards of material had been excavated from the channel.

It was believed, when dredging stopped, that a full width of 300 feet, 21 feet deep, had been obtained across the shoal; but no survey of the channel was possible up to May, 1885, when it was found that the side slopes of the cut had run into the channel, giving a clear depth of 21 feet for only 200 feet in the narrowest place, and an average width of over 250 feet.

An examination made during the summer of 1886 showed that no material shoaling had taken place since the survey of May, 1885.

In the Annual Report of Chief of Engineers for 1885, Part I, page 758, Colonel Gillespie, then in charge, estimated that to give this channel its full width of 300 feet would necessitate the removal of 80,000 cubic yards of material.

The original project of 1881 contemplated the excavation of this channel only; but Colonel Gillespie in his annual reports of 1883, '84, and '85, calls attention to two other shoals in the bay, west of Great Beds Light; one in the channel leading up to South Amboy, on the Raritan, and the other leading up to Perth Amboy on Staten Island Sound.

The shoal in the channel leading up to Perth Amboy is a middle ground, having a channel on each side of it, the eastern one being the best; but only from 18 to 19 feet of water can be carried through it. It is also narrow in places and crooked.

Colonel Gillespie recommended, therefore, that a straight channel 300 feet wide and 21 feet deep should be dredged from deep water near Great Beds Light through the east end of this shoal to deep water at Ward's Point, opposite Perth Amboy. (Report of Chief of Engineers, 1885, Part I, page 758.)

This, with the 21-foot channel dredged outside of Seguine Point, would give a continuous 21-foot channel from the main ship-channel in New York Bay to the wharves at Perth Amboy.

The amount of material required to be removed was estimated to be 150,000 cubic yards.

On the same page of the same report Colonel Gillespie calls attention to a shoal lying between South Amboy and Great Beds Light, on which there is only 12½ feet of water. And in order to give the large tow-boats running from New York up the Raritan sufficient water he recommended the excavation of a channel through this shoal 4,500 feet long, 300 feet wide, and 15 feet deep. The amount of excavation required to dredge this channel he estimated at 150,000 cubic yards.

The cost of dredging these two channels and the 80,000 yards of the side slopes of the cut outside of Seguine Point he estimated at a total of $114,000.

No money was appropriated or work done during the fiscal year ending June 30, 1886.

By act of August 5, 1886, an appropriation of $37,500 was made for the improvement of Raritan Bay.

Navigation through the channel leading eastward from Seguine Point is unquestionably easier and better than through the channels up to Perth and South Amboy, inside of the Great Beds Light.

Almost all the deep-draught trade of the Amboys is restricted to Perth Amboy, and vessels and steamers drawing up to 20½ feet load and unload at its docks. Its trade is so large and constant the year around that it would seem better to apply the present appropriation to widening and deepening the channel from Great Beds Light to Perth Amboy, rather than to apply it to widening the Seguine Point Channel or the South Amboy Channel.

As no survey of this part of the bay has been made since 1880, and as undoubtedly there have been some changes in the channels since then, a careful survey of the upper part of Raritan Bay should now be made from Great Beds Light to deep water off the docks at Perth and South Amboy, in order to determine the necessary lines of dredging in the channels, and the quantities of material required to be removed, and this and future appropriations should be applied: first, to the widening and deepening of the Perth Amboy Channel; second, to the South Amboy Channel, and last to the Seguine Point Channel.

The coal and iron trade of both the Amboys is very large; that of Perth Amboy especially so. In 1884, 116,000 tons of iron ore were imported, besides 30,923 tons of miscellaneous freight, and the exports amounted to:

	Tons.
Coal	1,946,129
Steel rails	80,709
Pig-iron	89,959
Grain and merchandise	29,194

And in 1885 the total number of tons shipped from Perth Amboy is stated to be 7,127,352 tons, with a valuation of $37,627,332.

A good deal of improper dumping of dredged material has been and is still done in Raritan Bay, to the detriment of the channels and oyster grounds.

All the material dredged from the channels of the bay and the rivers leading into them should be taken outside of Sandy Hook and dumped; but although a great deal of dredging has been carried on by private parties around Raritan Bay this summer, none of the men who have been employed on the Gedney's Channel improvement for many months has ever seen a tow of dump scows from the Raritan pass out by the Hook.

The lights around Raritan Bay are numerous: Great Beds Light (fixed red), at the junction of the Kill and Raritan; Prince's Bay Light (white flash), one-half a mile west of Seguine Point; Connover and Chapel Hill beacons, on the south shore of the bay; the range lights for the north and south Main Ship-Channel; Bay Side and Wilson's Beacon, range lights for passing Sandy Hook in the main channel going east and west; Elm Tree Beacon and New Dorp range lights, for the Swash Channel, besides the Sandy Hook lights.

Amount appropriated	$120,000 00
Amount expended	119,307 25

This work is in the collection district of Perth Amboy, which is the nearest port of entry; nearest light-house, Prince's Bay; nearest fort, fort at Sandy Hook. Amount of revenue collected during the fiscal year ending June 30, 1886, $31,067.65.

Money statement.

July 1, 1885, amount available	$724 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	31 95
July 1, 1886, amount available	692 75
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	38,192 75
Amount (estimated) required for completion of existing project	76,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	75,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 19.

IMPROVEMENT OF THE RARITAN RIVER, NEW JERSEY.

The Raritan is one of the largest rivers in New Jersey, running through the center of the State in a very tortuous course towards the east and emptying into Raritan Bay at its head, near the outlet of the Arthur Kill, or Staten Island Sound.

Perth Amboy is situated on the north bank, at the mouth, and South Amboy on the southern bank.

The head of navigation on the Raritan River is New Brunswick, situated 12½ miles above the mouth, although small boats can get up 5 miles further, to where the river is crossed by a dam which feeds the Delaware and Raritan Canal.

The river is tidal up to the dam.

The Delaware and Raritan Canal, the eastern end of which is at New Brunswick and the western end at Bordentown, form, with the Raritan River, a connecting link of water navigation between the cities of New York and Philadelphia.

So far as is known, the first survey of the Raritan River was made by Maj. Hartman Bache in 1836, being a part of the survey made "for the improvement of New Brunswick Harbor," and a project of improvement was formed, for the execution of which $7,000 were appropriated by act of July 4, 1836, and $6,963, act of March 3, 1837.

The details of the project and improvement are not on record in this office.

No work was done after this until 1878.

A survey of the river from New Brunswick to the mouth was ordered by act of June 10, 1872, and was made under direction of General (then Lieut. Col.) John Newton, Corps of Engineers, in 1873. His report may be found in Annual Report of Chief of Engineers for 1874, page 172, Part II.

The survey showed that, for the first 2½ miles up from the mouth, 20 feet of water or over could be carried, but for the next 2½ miles, over two shoals called the Stakes and Middle Ground, only 6 to 7 feet could be carried in places, with depths between them of 14 to 15 feet. The width of the river up to the head of the Middle Ground averaged half a mile, and the bottom was shifting sand, gravel, and mud.

For the next 3 miles, up to the mouth of South River (emptying into the Raritan 8½ miles above the mouth from the southward), the river deepens and narrows gradually, till it is about 350 feet wide. From the mouth of South River to New Brunswick it runs over rocky bars, with average depths of 8 feet and minimum depths of 7 feet, separated by stretches of water from 10 to 15 feet in depth. The width of the river is about 350 feet. The above depths refer to mean low water.

The tide at the mouth of the Raritan had a mean rise and fall of about 4.9 feet, or one-tenth more than at Sandy Hook, while at New Brunswick the mean rise and fall was 5.16 feet.

The flood tide at South Amboy had a maximum velocity of 1.05 nautical miles per hour, gradually diminishing as it went up to New Brunswick.

The maximum ebb current was 1.60 nautical miles per hour at South Amboy, and diminished in swiftness somewhat at the upper part of the river, but increased materially in duration.

The water of the river is fresh at New Brunswick.

As only 8 feet of water could be carried through the Raritan Canal, this seemed to fix the limit of depth which should be given to the river below, but as the superintendent of the canal stated that they were going to increase the depth to 10 feet, so as to make a through connection with the Chesapeake and Delaware Canal, which had a depth of 10 feet, the officer in charge thought it best to submit two estimates, which were as follows:

Object and locality.	Quantity and rate.	Amount.
A.—*Estimate of cost for permanent improvement for an 8-foot channel at mean low water (rock excavation extending to a depth of 10 feet at mean low water).*		
Gravel, sand, and mud shoal below New Brunswick locks.	52,700 cubic yards, at 35 cents...	$18,445 00
Rocks, 300 feet below New Brunswick locks............	2,399 cubic yards	76,768 00
Ledge of rock 3,300 feet above Martin's Dock..........	17,504 cubic yards	542,624 00
Reef of rocks opposite Martin's Dock	4,672 cubic yards	182,208 00
Reef of rocks covered with sand near Whitehead's Dock.	11,509 cubic yards	497,188 80
Middle Ground	55,505 cubic yards, at 35 cents...	19,444 25
Stakes	15,528 cubic yards, at 35 cents...	5,434 80
Dikes	11,400 feet, at $12.48 per running foot.	142,272 00
Contingencies	15 per cent. of the above........	222,657 73
		1,707,042 58
B.—*For a 10-foot channel at mean low water.*		
Dredging tidal basin..............................	648,000 cubic yards, at 40 cents..	259,200 00
Shoal commencing 160 feet below New Brunswick locks.	225,051 cubic yards, at 35 cents..	78,767 85
Rocks 300 feet below New Brunswick locks..........	2,399 cubic yards	76,768 00
Ledge of rocks 3,300 feet above Martin's Dock	17,504 cubic yards	542,624 00
Reef of rocks opposite Martin's Dock	4,672 cubic yards	182,208 00
Shoal below Widman's Dock	14,400 cubic yards, at 35 cents...	5,040 00
Reef of rocks, covered with sand, near Whitehead's Dock.	11,509 cubic yards	497,188 80
Middle Ground	55,555 cubic yards, at 35 cents...	19,444 25
Stakes	15,528 cubic yards, at 35 cents...	5,434 80
Dike	11,400 feet long, at $13.50 per running foot.	153,900 00
Contingencies	15 per cent. of the above........	273,086 35
		2,093,662 05

The tidal basin referred to was to be excavated in the river above the New Brunswick locks. General Newton made the inquiry in his report whether, as only $200,000 of this estimate would be expended up to a point just above the mouth of the South River (Whitehead's Dock), the Government should spend nearly $2,000,000 for the rest of the improvement (4 miles long) above, or whether the canal company should push the mouth of their canal down to Whitehead's Dock.

In 1871 the commerce of the Raritan Canal was 3,053,857 tons, with a value of $40,476,436.90.

The first appropriation made for this improvement was that of June 18, 1878, $200,000. Under this a contract was let to the lowest bidder, Henry Du Bois Sons, for the construction of 12,800 linear feet of pile diking at the Middle Ground and Stakes. As the timber was required to be creosoted, it was not till May, 1879, that the contractor commenced work, and by the close of the fiscal year 1,410 linear feet of the Middle Ground Dike (No. 2) had been completed, and 146 feet of Dike No. 3 at the Stakes.

In the fall of 1878 dredges, hired by the hour, were set at work on the shoals at the Middle Ground and the Stakes, and by December 42,663 cubic yards of sand, gravel, shells, &c., were removed. The dredges were put on again in April, 1879, and by the close of the fiscal year had removed 99,581 cubic yards of material.

In June, 1879, a dredge was put on the river near Whitehead's Dock, and removed during the month 5.170 cubic yards of blue and red shale, bowlders, and very compact blue clay.

A small Government drill-scow was also put in order, and borings were made above Whitehead's Dock to test the amount of rock required to be removed from the channel.

By act of March 3, 1879, the sum of $60,000 was appropriated, making $114,733.89 available June 30, 1879.

With this amount the contractors for Dikes Nos. 1, 2, and 3, having obtained an extension of their contract, completed these dikes by December, 1879. The total lengths of the dikes as completed up to that time was 12,639 feet, though erroneously printed in the Annual Report for that year as much less.

On October 15, 1879, a contract was let to William H. Wood for the extension of Dike No. 2 eastward 2,200 feet, and for the construction of a dike in the deep bend opposite Crab Island, known as Dike A.

Work on the former dike commenced in June, 1880, and up to the close of the fiscal year, 1888 piles had been driven. Dike A was commenced April 15, 1880, and by the close of the fiscal year it had been completed; its total length being 2,600.6 feet.

Dredging at the Stakes continued until the last of November, 1879, when 178,865 cubic yards had been excavated, making the total amount dredged from the shoals at that point of 268,315 cubic yards. The material was clay, sand, gravel, and shells, generally quite compact.

In December, 1879, the dredges were put to work on the Middle Ground, and continued until ice formed in the winter, during which time 23,850 cubic yards had been removed, making the total amount dredged from this shoal 76,644 cubic yards.

The dumping-grounds previously used had been quite filled up, and it became necessary to handle the material over a second time and deposit it behind the dikes.

The dredging, which had been begun in June, just above Whitehead's Sand Dock, in what is known as Rocky Reach, was continued up to the last of October, 1879, when 28,281 cubic yards of red and blue shale, small bowlders, and blue clay had been excavated.

On the resumption of work in February, 1880, the dredges were employed removing the rock which had been broken up by the blasts of the previous fall, and at the close of operations in May they had removed 10,125 cubic yards, of which about 7,000 cubic yards was broken rock. The material was deposited along the shores inside of lines previously established, close to the banks.

The small drill-scow completed the work of drilling test holes from Whitehead's Sand Dock up to New Brunswick. The results of these borings, added to the knowledge obtained in the survey of 1878, formed the basis for a revised estimate of cost for excavating a channel of 10 feet, and 12 feet deep, from above Whitehead's Sand Dock up to the canal lock at New Brunswick, as follows:

For excavating a channel 200 feet wide and 12 feet deep at mean low water, from 1,000 feet above Whitehead's Sand Dock to canal lock at New Brunswick:

Locality.	Object and rate.	Amount.
From 1,000 feet above Whitehead's Sand Dock to Lawrence Creek.	47,000 cubic yards of dredging, at $1	$47,000
From Lawrence Creek to 100 feet above Martin's Dock.	106,000 cubic yards of dredging, at $1	106,000
From 1,000 feet above Martin's Dock to end of Steamboat Dock.	2,600 linear feet of crib dike, at $15	39,000
	74,200 cubic yards of rock excavation, at $10	742,000
	184,000 cubic yards of dredging, at $1	184,000
From end of Steamboat Dock to canal lock	94,100 cubic yards of rock excavation, at $10	941,000
	27,800 cubic yards of dredging, at $1	27,800
	Contingencies, engineering, &c	313,020
Total		2,399,820

For excavating a channel 200 feet wide and 10 feet deep at mean low water from 1,000 feet above Whitehead's Sand Dock to the canal lock at New Brunswick:

Locality.	Object and rate.	Amount.
From 1,000 feet above Whitehead's Sand Dock to Lawrence Creek.	21,500 cubic yards of dredging, at $1	$21,500
From Lawrence Creek to 1,000 feet above Martin's Dock.	45,800 cubic yards of dredging, at $1	45,800
From 1,000 feet above Martin's Dock to end of Steamboat Dock.	2,600 linear feet of crib dike, at $15	39,000
	138,300 cubic yards of dredging, at $1	138,300
	4,700 cubic yards of rock excavation, at $15	70,500
From end of Steambot Dock to canal lock	56,800 cubic yards of rock excavation, at $15	568,000
	27,800 cubic yards of dredging, at $1	27,800
	Contingencies, engineering, &c.	136,635
Total		1,047 535

After completing the borings and removing some large bowlders from the channel a little above Martin's Dock the scow was taken to the reef above Whitehead's Sand Dock, and kept at work till December breaking up the rock. The rock broken up by it was only partially removed. On March 15, 1880, the scow was again put on the reef, and between that time and the suspension of work in the early part of May it raised and removed from the channel 1,484 cubic yards of broken rock.

By act approved June 14, 1880, $100,000 was appropriated, of which $70,000 was by law to be expended in the removal of rocks at Whitehead's Sand Dock (Rocky Reach), and $30,000 for dredging the shoals at the Middle Ground.

Under the contract with William H. Wood of October 15, 1879, in force July 1, 1880, 2,052½ feet of the extension of the south dike (B) were completed by the 15th of September, 1880, and the contract closed.

On October 15, 1880, a contract was made with John Van Patten for dredging a cut on the Middle Ground 200 feet wide, 12 feet deep at mean low water, and 5,300 feet in length, but the contract had not been finished at the close of the fiscal year.

The drill-scow resumed work on the Rocky Reach above Whitehead's Sand Dock in August 1880, and continued work till November 25, 1880, when the scow was laid up for the winter.

Operations were commenced again in the latter part of March, 1881, and were in progress at the close of the fiscal year, but as the blasted rock was allowed to accumulate in large quantities before being dredged, no idea could be given of the increased width obtained.

By act of March 3, 1881, $25,000 was appropriated, of which sum $20,000 was to be expended on the rocks at Whitehead's Sand Dock, "and $5,000 at the South Channel, between Crab Island and South Amboy."

Under the contract with John Van Patten, dated October 15, 1880, dredging was continued on the channel at the Middle Ground up to November, 1881, when the contract was closed; 57,700 cubic yards of material were removed during the contract, and gave a channel 130 feet wide, 12 feet deep at mean low water, and 5,300 feet in length.

Blasting and drilling with the scow on Rocky Reach, above Whitehead's Sand Dock, was continued throughout the year except in midwinter, and on October 15, 1881, a dredge was put on to assist in removing the broken rock. Operations were continued with this dredge, except in the winter, from October to the close of the fiscal year.

The amount of work done was 3,004 cubic yards removed by the drill scow, and 13,508 by the dredge. This work gave a channel through Rocky Reach 12 feet deep, 75 feet wide, and 1,000 feet long.

With the allotment of $5,000 for the south channel, a dredge was put onto the work in November, 1881, and worked until December 31, 1881, removing 7,825 cubic yards of material.

By act of August 2, 1882, $25,000 was appropriated. Of this $10,000 was allotted for the improvement of South Channel.

Work under this appropriation consisted in widening the channel at Rocky Reach, and was continued throughout the year, except when laid up for the winter. During this time 4,397 cubic yards of rock were removed by the drill-scow, 5,745 cubic yards by the dredge, and also 2,919 cubic yards of clay, 1,074 of shale, and 1,217 cubic yards of sand and gravel. The rock (except that taken up in May, 1882, and which was used for filling Dikes B and C in the South River improvement) was placed on the left bank of the river.

This work increased the width of the cut 59 feet, giving this channel, June 30, 1883, a total width of 134 feet, a depth of 12 feet at mean low water, and a length from deep water above to deep water below of about 1,000 feet.

With the allotment of $10,000 for the South Channel a contract was let October 2, 1882, to James D. Leary to dredge a cut, at 13 cents per yard, in the South Channel between "Crab Island and Kearney's Dock," 100 feet wide and 5½ feet deep at mean low water. The contractor commenced work October, 1882, but had to suspend operations from December to March, 1883. The contract was in progress June 30, 1883, when 46,740 cubic yards had been removed, making a channel 2,520 feet long for the full depth and width.

This channel commences at the lower end of Dike B, about midway across to the south bank of the river, and then runs parallel to the general incurve of the shore up to the head of Dike 1, where it joins again the main channel. It was designed by this channel to give egress to the commerce doing business on the southern side of the river and which was shut off by the dikes from the main channel.

No appropriation was made in 1883, but with the amount available June 30, 1883, $15,979.47, work was continued in dredging the South Channel under contract with J. D. Leary up till August 6, 1883, during which time 6,929 cubic yards of material were excavated. This carried the upper end of the cut to abreast of Such's Dock and gave it a total length of 4,000 feet; it was 100 feet wide and 5½ feet deep at mean low water. To complete this channel it will have to be extended 9,000 feet more up-stream in water a little over 1 foot deep at mean low water.

Work on Rocky Reach was continued with the drill-scow till December 20, during which time 3,173 cubic yards of rock were drilled, blasted, and removed. The rock was placed in the dike at the mouth of South River. This gave a channel width of 160 feet, with the exception of a few loose stones on the bottom which could not be removed before the suspension of the work.

By act of July 5, 1884, $35,000 was appropriated for continuing the improvement.

Under this appropriation work was resumed with the drill-scow on Rocky Reach; and at the close of the fiscal year ending June 30, 1885, the cut had been blasted out to its full width of 200 feet, except for a strip 700 feet long, and 20 feet wide at the lower end, but not all the blasted stone had been removed to full depth of 12 feet for more than a little over 160 feet. The work of its removal was going on at the close of the fiscal year.

On September 29, 1884, authority was given to dredge a small channel into Carman's (now Achman's) Wharf, behind Dike No. 3, as the water front had shoaled, owing to the construction of the dike; and a channel was dug up to it 500 feet long, 50 feet wide, and 6 feet deep at mean low water from the main channel.

In May, 1885, the dredge was removed to Bishop's Dock, about half a mile below the canal dock, at New Brunswick, to dredge through a shoal which had formed opposite to it during the winter, and a channel was opened through it 128 feet long, 100 feet wide, and 9 feet deep.

No money was appropriated in 1885.

With the balance of the appropriation of 1884 work was continued with the drill scow up to September 19, 1885, on Rocky Reach, during which time 6,392 cubic yards of rock were excavated.

The channel was drilled and blasted, and the material removed, for the full width of 200 feet throughout, except for a strip 20 feet wide and 150 feet long at the lower end. There yet remains this to be blasted and the débris to be removed.

The appropriation of $26,250 approved August 5, 1886, will be applied to this, and in extending the improvement above it 10 feet deep by dredging and blasting up-stream towards New Brunswick.

The condition of the improvement at present is as follows:

The proposed dikes have been completed from the mouth up to the mouth of South River, and a channel with a depth of not less than 11½ feet at mean low water has been obtained for a width of 200 feet over "The Stakes" Shoal, and for a width of 130 feet over the Middle Ground Shoal. The dikes are in good condition, except the lower 800 feet of Dike B, which has settled about 2½ feet, but it is not thought worth while to repair it at present.

A South Channel, 4,000 feet long, 100 feet wide, and 5½ feet deep, has been excavated south and east of dikes 1, 2, and 3 to relieve the commerce which cannot pass them into the main channel.

There yet remains on this lower part of the river to widen the channel at the Middle Ground Shoal 70 feet, to 12 feet in depth, and to continue the South Channel for 9,000 feet up-stream, 100 feet wide and 5½ deep.

On the upper part of the river, above the mouth of the South River, the only large work undertaken has been the blasting a channel 12 feet deep and 200 feet wide through Rocky Reach Bar, above Whitehead's Sand Dock, which is about 1,000 feet in length. This has practically been completed.

Above Rocky Reach no work has been done except to remove a few bowlders and dredging a short channel through a shoal formed during the winter of 1885.

The channel from Rocky Reach up to New Brunswick remains in about the same condition it was in when the first survey was made in 1872, when the depth in the channel varied from 7 to 12 feet at mean low water.

The Delaware and Raritan Canal has never been deepened to 10 feet, as originally stated to General Newton it would be.

The statement furnished by the superintendent of the steam towing of the Delaware and Raritan Canal Company, Mr. Chase (to be found in Annual Report of the Chief of Engineers for 1885, Part I, page 762), giving the commerce of the Raritan River in 1884 as 3,838,987 tons, shows little increase in its commerce since 1871, if any, as it must be remembered this estimate includes 2,258,853 tons received and shipped from South Amboy, situated at its mouth, which did not pass up or down the river at all, and may be said to belong to an entirely different improvement—Raritan Bay.

Taken from Annual Report of the Chief of Engineers, the statements of commerce, furnished entirely by the Delaware and Raritan Canal Company, show as follows:

Year.	Total value freight.	Freight on Raritan Canal.	Freight on Raritan River.	Freight, South Amboy.
		Tons.	*Tons.*	*Tons.*
1871	$47,476,436	3,053,857		
1880				
1881		1,527,579		
1882		1,280,141		
1883		1,682,325		2,308,961
1884	37,209,804	1,118,118	416,016	2,258,853

* This statement is given in the Annual Reports for 1885, but evidently refers to the calendar year of 1884. In this year the South Amboy trade of 2,258,853 tons had a value of $10,000,000.

The tonnage of the Delaware and Raritan Canal has decreased one-third, it will be seen, from 1871 to 1884. This is probably due to the coal which originally went through the canal now being shipped by rail to the Amboys, and thence loaded into large sea-going vessels.

The commerce of the river is carried on in vessels drawing from 4 to 14 feet, and certainly warrants giving a 10-foot channel from South River up, and a 12-foot channel from that point down to the mouth.

APPROPRIATIONS.

[For old project of 1836.]

Date of act.	Application.	Amount.
July 4, 1836	Unknown	$7,000
Mar. 3, 1837	Unknown	6,963
	Total	13,963

[For present project of 1872.]

Date of act.	Application.	Amount.
June 18, 1878	Building dikes and dredging	$200,000 00
Mar. 3, 1879	Building dikes, dredging, and blasting	60,000 00
June 14, 1880	Blasting at Rocky Reach, and dredging	100,000 00
Mar. 3, 1881	Blasting and dredging at Rocky Reach, and dredging South Channel	25,000 00
Aug. 2, 1882	....do	25,000 00
Aug. 5, 1884	Blasting and dredging at Rocky Reach	35,000 00
Aug. 5, 1886		26,250 00
	Total	*471,250 00
	Amount expended	444,582 82
	Estimated cost of present project	2,093,662 65
	Still to be appropriated	1,622,412 65

* Of this, $15,000 was applied to South Channel, which did not come into the original estimate.

This work is in the collection district of Amboy. Nearest port of entry, Perth Amboy; nearest light-house, Great Beds Light, Raritan Bay. Amount of revenue collected at the port of Perth Amboy during the year ending June 30, 1886, $31,067.65.

Money statement.

July 1, 1885, amount available	$10,727 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	10,109 43
July 1, 1886, amount available	617 98
Amount appropriated by act approved August 5, 1886	26,250 00
Amount available for fiscal year ending June 30, 1887	26,867 98
Amount (estimated) required for completion of existing project	1,622,412 05
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Statement showing the tonnage, valuation, &c., of the commerce of the Raritan River, New Jersey.

Shippers.	Products of the forest.	Products of mines and quarries.	Products of animals.	Agricultural products.	Manufactures.	Merchandise.
	Tons.	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Delaware and Raritan Canal Company	16,764	601,714				214,122
South Amboy		2,122,213				
South River Canal	2,500	21,300	1,000	4,000	110,000	1,000
New Brunswick Dock						12,000
Sayre & Fisher	10,000				90,000	
C. & W. Whitehead		50,000				
Middlesex Fire-brick Company		7,000			1,500	1,500
Roberts Brothers		2,800				
Phœnix Brick Company					14,000	
Ridgway & Brother		3,800				
F. A. Ostrander		5,000				
Raritan River Company		3,000				
Raritan Hollow-brick Company		10,000			20,000	
American Fire-brick Company		5,000			15,000	
Thomas Acker & Company		3,000				
Edgar & Compton		5,000				
Edgar & Brother		10,000				
Martin's Dock	100	300				
Terrence Cherry	500			250	4,500	4,500
Watson Fire-brick Company		1,000			10,000	
T. & H. Valentine		10,000			10,000	
Total	29,864	2,861,127	1,000	4,250	275,000	233,122

Statement showing the tonnage, valuation, &c.—Continued.

Shippers.	Miscellaneous.	Freight shipped.	Number of vessels.	Average draught of vessels.	Tonnage of vessels.	Valuation of freight.
	Tons.	*Tons.*		*Feet.*		
Delaware and Raritan Canal Company	212, 608	1, 045, 208	....	7	25 to 200	$25, 000, 000
South Amboy	108, 251	2, 225, 464	15, 849	10	100 to 300	10, 000, 000
South River Canal	....	139, 800	....	5	25 to 100	417, 000
New Brunswick Dock	....	12, 000	....	7	100	100, 000
Sayre & Fisher	....	100, 000	....	9	50 to 300	350, 000
C. & W. Whitehead	....	50, 000	....	8	50 to 250	100, 000
Middlesex Fire-brick Company	....	10, 000	....	6	25 to 100	20, 000
Roberts Brothers	....	2, 800	....	6	25 to 100	10, 000
Phœnix Brick Company	....	14, 000	....	6	25 to 100	45, 000
Ridgway & Brother	....	3, 800	....	6	25 to 100	10, 000
F. A. Ostrander	....	5, 000	....	6	25 to 100	15, 000
Raritan River Company	....	8, 000	....	6	25 to 100	10, 000
Raritan Hollow-brick Company	....	80, 000	....	7	100 to 200	125, 000
American Fire-brick Company	....	20. 000	....	8	100 to 200	100, 000
Thomas Acker & Company	....	3, 000	....	7	100 to 200	10, 000
Edgar & Compton	....	5, 000	....	7	100 to 200	10, 000
Edgar & Brother	....	10, 000	....	8	100 to 200	25, 000
Martin's Dock	....	400	....	7	100 to 200	1, 500
Terrence Cherry	....	9, 750	....	7	100 to 250	65, 000
Watson Fire-brick Company	....	11, 000	....	7	100 to 250	115, 000
J. & H. Valentine	....	20, 000	....	7	100 to 250	45, 000
Total	315, 854	3, 720, 217	....	....	....	36, 573, 500

E 20.

IMPROVEMENT OF SOUTH RIVER, NEW JERSEY.

South River, New Jersey, draining a country 30 miles long and 10 miles wide, is a small tidal stream entering the Raritan River from the south about 8¼ miles above South Amboy and 4 miles below New Brunswick. Its width varies from 100 to 500 feet for the first 10 miles up. The bottom is sand and clay, and the river is obstructed by frequent bars with from 2 to 5 feet of water upon them, separating short stretches of water from 7 to 12 feet deep. The mean rise and fall of tides at Little Washington is 5.3 feet.

The stream runs for most of the distance through low marsh lands, and is as crooked as most marsh streams. At a point 2½ miles above its mouth South River is only about 4,000 feet distant from a point on the Raritan River, 1½ miles below their junction. In order to avoid this circuitous route to and from the towns lying on this river, a cut or canal about 80 feet wide across this narrow neck was made in 1831 by the New Jersey Transportation Company, which practically saves 3 miles of transportation. It was intended to make this cut 6 feet deep, but this depth was never attained.

The village of Little Washington, about half a mile above the head of this canal, was and is now the head of steamboat navigation on the South River.

The first survey by the general Government, made with a view to the improvement of this river, was ordered by act of Congress approved July 11, 1870, and the survey was made under direction of Lieut. Col. J. D. Kurtz, Corps of Engineers, in 1870. His report may be found in the Annual Report Chief of Engineers for 1871, page 698.

The project of improvement based upon this survey provided for obtaining, by dredging, a 6-foot channel from the mouth of the canal up to the town of Little Washington. The estimated cost of this was:

Deepening the cut to 6 feet, 21,233 cubic yards, at 35 cents	$7,431 55
Opening a channel through the shoals between the head of the canal and Little Washington, 14,444 cubic yards, at 35 cents	5,055 40
Making an oblique cut into the Raritan (so as to prevent shoaling at the mouth), 3,333 cubic yards, at 35 cents	1,166 55
Total	13,653 50

The business of the river was stated to be large, consisting of manufactures of tobacco, snuff and cigars, whisky, rubber, spices, flour, &c., to the value of $1,254,543.55 annually, besides the product of a number of brick factories, which turned out 72,000,000 brick a year.

The first appropriation for the improvement under this project was made March 3, 1871, $15,000, but, owing to the failure of a contractor, work was not commenced till 1872, when a channel 6 feet deep was dredged through the canal, but the banks fell in and partly filled up the cut, and it was redredged in 1872–'73.

Under date of March 3, 1873, a further appropriation of $5,000 was made, and the dredging was continued. Upon the completion of this work the cut had a depth of 6 feet again. From this time nothing further was done on the river until 1879, when a resurvey was ordered by act of March 3, 1879, which was made under direction of General (then Col.) John Newton, Corps of Engineers.

Based upon this survey a project was made to form a channel by means of dredging and diking, including a cut across the neck of a long bend in the river above Little Washington, up to Old Bridge, a total distance of 6 miles from the mouth of the canal. The depth to be obtained was 8 feet from the mouth of the canal to Little Washington, 6 feet from that point up to Bissett's brick-yard, about 3¾ miles above the mouth, and 4 feet from there up to Old Bridge.

The estimated cost of this was—

From Raritan to Bissett's	$149,150
From Bissett's to Old Bridge	20,150
Contingencies	25,395
Total	194,695

The project also contemplated closing the old main channel below Pettit's brick-yard, half a mile below the head of the canal, so as to throw the whole current into the canal instead of having it pass through two outlets into the Raritan; and to change the position of the mouth so as to have the canal enter the Raritan more down-stream than before. By act of June 14, 1880, $40,000 were appropriated for this work.

Upon inquiry it was found that the newly proposed direction of the mouth of the cut would interfere with private property, and much time was spent in trying to adjust the matter. Eventually, Messrs Sayre & Fisher, owning a brick-yard at the junction of the Raritan River and the canal, offered to allow the Government to cut off the corner of their dock on condition of protecting the bank cut off by piling (see page 660, Annual Report of the Chief of Engineers for 1881, Part I).

In the mean time the cut, or canal, had shoaled to a depth of 3½ feet in places. Owing to the delay in making out the deeds transferring this point of land to the United States, no work was done on this improvement during the fiscal years ending June 30, 1881, and June 30, 1882. By act of Congress approved March 3, 1881, $6,000 more was appropriated, and $10,000 by act of Congress of August 2, 1882.

On July 20, 1882, proposals were opened for diking and dredging at the entrance of the canal into the Raritan River. A sketch of the proposed improvement may be found in Annual Report of the Chief of Engineers for 1882, Part I, page 678.

The proposals were not considered satisfactory, and the work was re-advertised, and on October 2, 1882, a contract was let to Henry Du Bois Sons for removing and rebuilding the corner of Sayre & Fisher's Wharf, constructing six dikes—A, B, C, D, E, and F—whose total length was 5,800 feet (for sketch, see Annual Report of the Chief of Engineers for 1885) and dredging about 6,232 cubic yards of material.

Under the terms of this contract the contractor was not to fill dikes A, B, and C with stone, as it was expected to fill them with the stone removed from Rocky Reach in the Raritan River.

At the close of the fiscal year ending June 30, 1883, the corner of Sayre & Fisher's Dock had been rebuilt, Dike A had been completed for 352 feet, B for 621 feet, C for 275 feet, D for 1,551 feet; and Dike B had been filled with stone for 40 feet, Dike C for 122 feet.

The contract for dike construction and dredging, owing to unavoidable delays, had to be extended to October 31, 1883, under it; Dike E, measuring 1,320 feet, was completed in July; Dike F, extending from the head of the canal up to the right bank to and across Little Ditch below Little Washington, measuring 1,797 feet, was completed in September, 1883, and the contract closed.

The closing of Little Ditch was authorized by the Secretary of War, August 23, 1883.

The contractor did no dredging, as it was found the scows would not hold the sand.

The steam-drill scow at work on the Raritan River was sent up during the year to the channel above Little Washington, and pumped up 2,222 cubic yards of material, making a cut 300 feet long, 40 feet wide, and 6 feet deep, giving a channel through that part of the shoal 130 feet wide. Three thousand and seventy-three cubic yards of broken stone, blasted from Rocky Reach in the Raritan River were placed in dikes A, B and C, completing their filling for 292 linear feet. The width of the natural channel between the dikes built at the north end or outlet of the canal into the Raritan River and between the natural banks is 150 feet.

No funds were available and no money was spent during the fiscal year ending June 30, 1884; but 1,200 cubic yards of broken stone, taken from the Raritan River at Rocky Reach, were placed in the dikes.

No money has been available and no work done during the fiscal year ending June 30, 1886, except that some more of the stone excavated from Rocky Reach in the Raritan River has been placed in the dikes.

An examination recently made shows that the channel from Little Washington to the head of the canal has improved, there being nowhere a depth of less than 7 feet at mean low water. A shoal with 7 feet of water on it has formed at the junction of the old channel and the head of the canal; but it does not affect the channel down to the canal.

The mouth of the canal has scoured out to a depth of 10½ feet, the scour being principally along the dike on the left bank; but the middle part of the canal has not improved in depth. Six feet can be carried through it at mean low water, but there are bars and shoals with 5.5 feet of water on them putting out into the stream, which make it almost impossible to get 6 feet of water through them; and the banks of the canal above the dikes are being undermined and are cutting away rapidly.

It will unquestionably become necessary before closing the main channel below Pettit's, and forcing the whole strength of the ebb and flood through the canal, to extend the present diking up to its head, a distance of about 2,000 feet, on each side of the canal.

If this were done, and the old cut closed, the natural scour would undoubtedly maintain a 7 or 8 foot channel, and probably excavate it.

There is little use of extending the improvement up-stream until the canal is given a fixed depth of 6 feet or over.

All the traffic from Pettit's comes through the canal, and there is no trade below Pettit's down to the old mouth, so that the closing of the channel would not damage anybody's interest.

The commerce of the river is undoubtedly large for so small a stream; but it has not increased materially since 1872.

The freight alone, in 1871, was given a value of $1,254,543, but in 1885 the freight and vessels were valued at $1,852,000; and the brick-making interest, which, in 1871, was estimated at 72,000,000 yearly, was in 1884 only estimated at 50,000,000. The commerce of this river is done in sloops and schooners of from 4 to 7 feet draught.

Five thousand dollars was appropriated by act of Congress August 5, 1886, and will be expended upon the dikes on each side of the canal towards its head, or to dredging in the canal if it should become necessary.

This work is in the collection district of Amboy. The nearest port of entry, Perth Amboy, N. J. Nearest light house, Great Beds Light, in Raritan Bay, New Jersey. Nearest fort, fort at Sandy Hook, New Jersey. Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, $31,067.65.

Original estimate for project of 1879, $194,695.

APPROPRIATIONS.

[For old project of 1871.]

Date of act.	Application.	Amount.
March 8, 1871	Dredging	$15,000 00
March 3, 1873	do	5,000 00
Total		20,000 00
Amount expended		20,000 00

[For new project of 1879.]

Date of act.	Application.	Amount.
June 14, 1880	For diking and dredging	$40,000 00
March 3, 1881	do	6,000 00
August 2, 1882	do	10,000 00
August 5, 1886		5,000 00
Total		61,000 00
Amount expended to date		55,638 73

Money statement.

July 1, 1885, amount available	$382 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	21 36
July 1, 1886, amount available	361 27
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,361 27
Amount (estimated) required for completion of existing project	133,695 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 21.

IMPROVEMENT OF WOODBRIDGE CREEK, NEW JERSEY.

Woodbridge Creek is a small tidal creek, about 5 miles long, emptying into the Arthur Kill, or Staten Island Sound, on the west bank, 2 miles above and north of Perth Amboy, N. J.

It is navigable for 2½ miles above the mouth, up to which point it averages 100 feet in width. There is little land drainage into it. The stream itself is crooked, and runs for the most of its length through flat marshes.

It is, commercially, the most important tributary of Staten Island Sound, on account of the extensive and valuable fire-clay beds adjacent to it. On its banks are 7 fire-brick and tile factories, with several docks at which fire-clay is loaded into vessels for export. The commerce of the creek is done entirely in schooners and sloops drawing from 5 to 10 feet. The rise and fall of tide is 5 feet approximately.

The first survey, with a view to its improvement, was ordered by act of Congress approved June 18, 1878. The survey was made under direction of Col. J. N. Macomb, Corps of Engineers, in the fall of 1878, and reported upon December 27, 1878. It may be found in Annual Report of the Chief of Engineers for 1879, Part I, page 478.

The report showed that the commerce of the creek extended 2 miles up from the mouth to the Salamander Dock with varying depths of from 7½ to 15 feet at mean high water, corresponding to 2½ feet and 10 feet at mean low water, the worst two shoals being at the mouth and from Valentine's Dock to the Salamander Dock. It was, therefore, proposed to open a channel 12 feet deep at mean high water, 80 feet wide from the mouth to Valentine's Dock, and 80 feet wide and 10 feet deep from Valentine's Dock to the Salamander Dock, which lies next to and above the Town Dock; also, to contract the channel just below the Town Dock by a 500-foot dike. This was estimated to cost as follows:

29,012 cubic yards dredging, at 30 cents	$8,703 60
500 linear feet pile-dike, at $4	2,000 00
Contingencies	1,605 54
Total	12,309 14
In addition to this there was a contingent estimate for continuing the 12-foot channel up to the Salamander, 5,000 cubic yards, costing	1,500 00
Total estimated cost of project	13,809 14

At that date the tonnage of fire brick and clay leaving the creek was 109,367 tons in the year, and the receipts 5,200 tons.

The first appropriation for this improvement was made March 3, 1879 ($4,000), which was applied to widening and deepening the channel above Valentine's Dock and building a pile revetment on the north bank.

June 14, 1880, an appropriation of $5,000 was made. Under this a contract for dredging was let to Elijah Brainard, at 58¾ cents per cubic yard, and 7,022 cubic yards were excavated from the bar at the mouth and from the channel up to Boynton's Dock by November 24, 1880, when the appropriation was exhausted.

The Annual Report of the Chief of Engineers for 1881, Part I, page 708, Colonel Michler, Corps of Engineers, then in charge, states that 12,554 cubic yards had been removed up to June 30, 1881, with the $9,000 appropriated up to that time, out of a total of 34,000 cubic yards called for by the original estimate, and that the dredging had cost very much more per cubic yard than was originally estimated, so that it was not probable that the project could be completed with less than $14,000 more than had been already appropriated, making the total estimated cost of executing the project $23,000 instead of a little over $13,000.

Under the appropriation of $5,000, made by act of Congress approved March 3, 1881, a contract was entered into with John Van Patten at 65 cents per cubic yard for dredging. Work under this contract was begun September 12, 1881, and was completed November 10, 1881, during which time 7,324 cubic yards of material were excavated. The work consisted of widening and deepening to 12 feet the channel already dredged up to just above Anderson's Dock, 1 mile above the mouth.

By act of Congress of August 2, 1882, $5,000 more was appropriated, and under it a contract for dredging was let to Elijah Brainard at 65 cents per cubic yard. Work was begun December 18, 1882, and the contract was completed January 17, 1883. The amount excavated was 6,880 cubic yards, leaving 7,242 cubic yards to be excavated to complete the existing project.

This gave a 12-foot channel, 80 feet wide, from the mouth up to a little beyond Cutter's Dock; thence to Valentine's Dock, 12 feet deep and 25 feet wide; thence to the head of navigation, Salamander Dock, just above the Town Dock, a channel 80 feet wide and 9 feet deep. The above depths refer all to mean high water; and a dike 516 feet on the north bank had also been completed. The estimate for the completion of the project was $9,000. No work was done in 1884 and none in 1885, when the cost of the completion of the project was estimated at $10,000. No work has been done since 1883, nor has any money been appropriated.

An examination made in the summer of 1886 shows that the channels have not shoaled since 1883, when the last dredging was done.

The commerce of the creek has not improved of late years, the tonnage being in 1885 120,000 tons, against an average of 126,000 tons per year for the ten years ending 1878.

In view of this, and of the fact that the commerce of the river can be done on the existing water, no further appropriation is recommended at present.

Woodbridge Creek is in the collection district of Perth Amboy, N. J., which is the nearest port of entry; nearest light-house, Great Beds Light, in Raritan Bay; nearest fort, fort at Sandy Hook, New Jersey Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, $31,067.65.

REVISED ESTIMATE OF 1883.

For dredging a channel 80 feet wide and 12 feet deep, mean high water, and 4,800 feet long, and constructing a timber dike 516 feet long $29,000 00

AMOUNTS APPROPRIATED.

Date.	Application.	Amount.
March 3, 1879	Dredging and diking	4,000
June 14, 1880	Dredging	5,000
March 3, 1881	do	5,000
August 2, 1882	do	5,000
		19,000

Amount expended, $19,000.

Money statement.

Amount (estimated) required for completion of existing project....... $10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

E 22.

IMPROVEMENT OF RAHWAY RIVER, NEW JERSEY.

The Rahway River is formed by the junction, at the town of Rahway, N. J., of two small streams; thence it runs in an easterly direction, as a tidal river, 5 miles, to the Arthur Kill, or Staten Island Sound, which it enters about 2 miles south of the village of Elizabethport.

The town of Rahway is at the head of navigation. The width of the stream at the mouth is about 350 feet, gradually narrowing to 150 feet at the head of navigation. The depth at the mouth prior to the first improvement was about 13 feet at mean high water, gradually shoaling to 8 feet at Bricktown, 4 miles up, and thence gradually shoaling to 4 feet to the head of navigation.

The mean rise and fall of the tide is said to be 5.3 feet near the mouth and 4 feet at the Milton Avenue Bridge, in the town of Rahway. The banks of the river are low and the surrounding country up to Rahway consists of salt marsh.

The commerce of the river consisted, in 1878, of coal, lumber, and sundries, estimated at 120,500 tons annually, with a value of $987,000.

The first survey with a view to the improvement of this river was made in 1878 under direction of Col. J. N. Macomb, Corps of Engineers.

The report upon this survey may be found in Annual Report of the Chief of Engineers for 1879, page 483, Part I.

The report took the ground that from the mouth up to Bricktown, a distance of 3¾ miles, there was sufficient water for the requirements of navigation; but in order to accommodate commerce from Bricktown up to Rahway, it was proposed to dredge a channel 125 feet wide and 8 feet deep at mean high water from Bricktown to Milton Avenue Bridge, a distance of a little more than a mile; and thence to the head of navigation at Main Street Bridge, a quarter of a mile further up, to dredge a channel 8 feet deep at mean high water and 100 feet wide.

The estimated amount of excavation required for this work was 65,642 cubic yards of mud, sand, and gravel, with a few bowlders, which at 50 cents per yard would cost $32,821, to which was added $500 for excavating one bowlder in the channel at Bricktown and another about 600 feet above Long Branch Railroad Bridge; add for contingencies $3,332, making the total cost of improvement $36,653.

The first appropriation for this improvement was approved March 3, 1879, $10,000.

And in the autumn of 1879 a contract was let to E. G. Brown for dredging a channel 75 feet wide and 7 feet deep at mean high water from Edgar's Dock, half way between Bricktown and Milton Avenue Bridge, towards the head of navigation.

Work under this contract was begun October 4, 1879, and was continued up to November 22, 1879, when operations were suspended for the winter. Up to this date 2,733 cubic yards of material had been excavated, giving the proposed increase of width and depth of channel for 400 feet up-stream from the point of beginning.

Work was not recommenced in the spring of 1880 by Mr. Brown, and the contract was therefore annulled.

By act approved June 14, 1880, $10,000 more was appropriated for this work, making a total amount available June 30, 1880, of nearly $18,000.

And bids were asked for continuing the dredging. Only two bids were received, and both were rejected, and the work was readvertised. Bids, under the second advertisement, were opened October 25, 1880, and a contract was awarded at 85½ cents per cubic yard to John Van Patten.

Owing to the lateness of the season work could not be begun until April 16, 1881; and it was continued to September 10, 1881, when the contract was closed. Under it there had been excavated 9,337 cubic yards of sand, gravel, and mud, and the 7-foot channel had been extended up to Tappan's Dock.

An appropriation of $10,000 was made by act of March 3, 1881; and bids were opened for continuing the dredging October 18, 1881. William Chamberlain was the lowest bidder, at 63 cents per cubic yard, and a contract was awarded to him.

Owing again to the lateness of the season work was not commenced till May 6, 1882. It was continued till August 28, 1882, during which time 13,943 cubic yards of material had been excavated, giving a channel 50 feet wide and 7 feet deep at mean high water up to a point 200 feet above the Milton Avenue Drawbridge, with a channel on each side of the draw-pier.

It was estimated on June 30, 1882, that the total amount of material to be excavated under the original project would be increased from 65,642 cubic yards to 90,000 cubic yards.

This increase was said to be due to the filling in of the channel from the sides, shoaling from freshets, and from the difference between scow and place measurement; and which increased the total estimated cost from $37,000 to $66,250, of which $30,000 had been appropriated up to June 30, 1882.

By act approved August 2, 1882, a further sum of $7,000 was appropriated; and bids for continuing the dredging were opened, after advertisement, September 22, 1882. The contract was awarded to the lowest bidder, Mr. William Chamberlain, at 78 cents per cubic yard.

Work under this contract was not begun until June 1, 1883, and was continued up August 31, 1883, during which time 8,309 cubic yards of material were excavated.

At the close of the work a channel had been carried from the upper end of the last contract 50 feet wide and between 7 and 8 feet deep up to a point 850 feet above the Milton Avenue Bridge, and the channel leading to Chamberlain's Dock had been widened and deepened.

An improved channel, therefore, of not less than 7 feet in depth and not less than 50 feet in width, had been obtained up to within 550 feet of the Main Street Bridge, which was the head of navigation.

No money has been appropriated since August 2, 1882, and no work has been done since August 31, 1883.

The total amount appropriated up to June 30, 1886, for this improvement is $37,000, with which a total of 34,322 cubic yards have been excavated from the channel, leaving an estimated amount of 55,000 cubic yards still to be excavated under the original project of 55,000 cubic yards, estimated in 1882 to cost 65 cents per cubic yard, or $35,750.

Judging from the last contract price, it will cost 13 cents per cubic yard more than this, or 78 cents per cubic yard.

The commerce of the river does not seem to have been increased. though the improvement has been a great benefit to shippers.

	Tons.
In 1879 the commerce of the river was reported as	120,500
In 1880 (not given).	
In 1881 the commerce of the river was reported as	68,500
In 1882 the commerce of the river was reported as	49,000
In 1883 the commerce of the river was reported as	51,000
In 1884 the commerce of the river was reported as	48,500
In 1885 no material change from 1884.	

In the Annual Report of the Chief of Engineers for 1885 it is stated that—

> As small sailing craft and canal barges alone use the upper portion of the river, for which the existing depths of water are ample, no appropriation is recommended for further improvements.

I fully concur in this opinion.

The mouth of the Rahway River is situated on Staten Island Sound, about 9 miles above Great Beds Light, in Raritan Bay, and about 4 miles below the light at the entrance of Newark Bay.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. The nearest fort is Fort Tompkins, Staten Island. Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1886, was $31,067.65.

Original estimate of 1878	$36,653
Modified estimate of 1882	66,250

APPROPRIATIONS.

Date.	Application.	Amount.
Mar. 3, 1879	Dredging	$10,000
June 4, 1880	......do	10,000
Mar. 3, 1881	......do	10,000
Aug. 2, 1882	......do	7,000
		37,000

Amount expended to June 30, 1886, $36,820.40.

Money statement.

July 1, 1885, amount available	$200 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	21 10
July 1, 1886, amount available	179 60
Amount available for fiscal year ending June 30, 1887	179 60
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	29,250 00

E 23.

IMPROVEMENT OF THE ELIZABETH RIVER, NEW JERSEY.

The Elizabeth River, New Jersey, enters the Arthur Kill, or Staten Island Sound, at Elizabethport, half mile south of the lower and southern end of Newark Bay. It should more properly be termed a creek, as it has very little land drainage entering it, and consists of a sluggish tidal stream averaging 75 feet in width for nearly the first 4 miles up, where a dam crosses the river and cuts off the land drainage water coming from its head.

The first survey of this stream was made in 1878, under direction of Col. J. N. Macomb, Corps of Engineers, and extended about 2¾ miles up from the mouth to the Broad Street Bridge, in the city of Elizabeth, N. J.

The dam above mentioned lies about 1 mile above this bridge; the mean rise and fall of the tide at the mouth of the river is stated to be 4.7 feet, and at the Broad Street Bridge to be 3.4 feet.

At the time of the survey the depth at mean high water at the mouth was about 8.5 feet, and the depth at Broad Street Bridge, and in quite a long reach below it, was from 3 feet to 3.5 at mean high water.

It was stated that material shoaling had taken place in the river during the 20 years previous to the survey, and that from 5 to 6 feet of water had existed up to Broad Street Bridge, instead of 3 to 3.5 feet, as at the time of the survey; that this shoaling was partly due to one-quarter of the fresh water volume being lost by the construction of the water-works dam, and partly on account of the discharge of the whole sewage of Elizabeth and of the gas works into the stream.

The commerce of the river in 1870 was stated to amount to 125,000 tons per year, carried in canal boats and market vessels drawing from 3 to 5 feet; but since that time it has been far less.

The details of the survey and the project accompanying it may be found on page 481, Report of the Chief of Engineers for 1879, Part I.

The project was briefly to dredge a channel 60 feet wide to a depth of 7 feet at mean high water from the mouth of the Broad Street Bridge, a distance of 2.7 miles, which would require the removal of 44,000 cubic yards of gravel, mud, sand, and small stones, at an estimated cost of 50 cents per cubic yard; which with 15 per cent. added for contingencies would cost $25,530.

By act of Congress approved March 3, 1879, an appropriation of $7,500 was made for the improvement; and, under it, dredging was begun under a contract awarded on September 19, 1879, to E. G. Brown, at 37 cents per cubic yard, and was continued until December 20, 1879, when work was suspended for the winter. Work was resumed under the contract on February 24, 1880, and was still being carried on at the close of the fiscal year ending June 30, 1880, on which date a continuous channel about 60 feet wide and 7 feet deep at mean high water had been carried up to the foot of John street, 4,110 feet above the place of beginning.

On the 14th of June an additional appropriation of $7,500 was made, and a contract was entered into with Thomas H. Benton to continue the dredging at $1.05 per cubic yard. Operations under this contract were begun October 1, 1880, and were carried on until November 27, 1880, when work was suspended for the winter.

The work was resumed March 14, 1881, and was continued until April 26, 1881, when the available funds were exhausted and the contract was closed.

During the year, 9,200 cubic yards of material were excavated and placed on the adjacent river banks, making the total amount excavated to that date 21,078 cubic yards, which carried the channel up stream from the place of beginning to a point about 150 feet below the South Street Bridge.

As the first contract had been carried out, as it was claimed, at a loss to the contractor, and as the second year's work had been done at the rate of $1.05 per cubic yard, it was estimated that the remainder of the improvement, requiring the excavation of 23,322 cubic yards of material, would cost about $28,160.

The river and harbor act of March 3, 1881, appropriated $4,000 for the improvement of this river, and proposals for further dredging were opened June 16, 1881, after public advertisement, and a contract awarded to Thomas H. Benton, the lowest responsible bidder, at $1.05 per cubic yard.

Work under this contract was commenced July 18, 1881, and by August 25, 1881, when 3,335 cubic yards had been excavated, the funds were exhausted and the contract was closed; at this time a 7-foot channel had been carried up to the iron draw-bridge at South street, above the gas-works.

The amount remaining to be excavated under the original estimate was 19,987 cubic yards, which, on July 30, 1882, was estimated to cost $24,134, including contingencies.

By act of Congress approved August 2, 1882, the sum of $8,000 was appropriated for continuing the improvement; and, after advertisement, bids were opened September 22, 1882, for further dredging. The lowest bidder was F. C. Somers, at 64 cents per cubic yard. The contract was awarded to him; but operations were not begun until May 26, 1883. Work was continued from that date up to August 21, 1883, during which time 11,094 cubic yards of material had been excavated, and which carried the improved channel up to near the Bridge Street Bridge, with a width of about 60 feet and a depth of 7 feet, mean high water.

No work has been done since August 21, 1883, and, in the Annual Report for 1884, Part I, page 748, it is stated that "the original project is completed so far as the present wants of commerce require, and the stream now affords ample depth for all the vessels or boats which use it."

I fully concur in this statement.

The tonnage of the stream since the beginning of the improvement has run from 20,000 to 30,000 tons per year, and the cause of the shoaling of the upper part of the river is entirely due to the refuse from the sewers and gas-works of the city. No appropriation, therefore, is asked for a further improvement.

The modified estimate of cost of this improvement amounted to $43.160, of which $27,000 has been appropriated.

Elizabeth is in the collection district of Newark, N. J. Nearest light-house, Newark Bay; nearest fort, Fort Tompkins. Amount of revenue collected at the port of Newark, N. J., during the fiscal year ending June 30, 1886, $2,326.70.

Original estimate of 1878, for dredging	$25,530
Additional estimate of 1882, for dredging	17,630
Total	43,160

APPROPRIATIONS.

Date.	Application.	Amount.
Mar. 3, 1879	Dredging	$7,500
June 14, 1880	......do	7,500
Mar. 3, 1881	......do	4,000
Aug. 2, 1882	.....do	8,000
	Total	27,000

Amount expended to June 30, 1886, $26,419.16.

Money statement.

July 1, 1885, amount available	$601 64
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	20 80
July 1, 1886, amount available	580 84
Amount (estimated) required for completion of existing project	16,160 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

ing the fiscal years ending June 30, 1877, and June 30, 1878. By act of June 18, 1878, a further sum of $25,000 was appropriated, but no work was done during the fiscal year ending June 30, 1879.

The act of June 14, 1880, appropriated $29,000 for the improvement, making the total amount then available for the improvement on June 30, 1880, $52,006.37.

A project for the expenditure of the money was made by Col. N. Michler, Corps of Engineers, June 28, 1880, and was forwarded to the Chief of Engineers.

It was referred by him to the Board of Fortifications and River and Harbor Improvements, whose report may be found in Annual Report of the Chief of Engineers for 1881, Part I, page 693.

Their report concurred in the previous reports of General Newton and of the special Board of April, 1875, but the Board stated that the commerce of the Kills had increased since 1875, so as to warrant an increased channel depth, and they therefore proposed to dredge a deeper channel from Elizabethport eastward to the deep water of the Kill von Kull on the lines of the existing channel to the south of Shooter's Island, the channel to be 400 feet wide and 12 feet deep at the sides at mean low water, with an extra depth of 1 foot for 100 feet in width on each side of the axial line of the channel, so that there would be at mean low water a depth of 13 feet over the middle 200 feet of the channel and 12 feet on the outer 100 feet on each side.

In addition to this dredging, if it were found necessary to confine and direct the current, parallel dikes were to be built on opposite sides of the channel at two places; one pair about 1,500 feet long near Elizabethport and one pair just west of Shooter's Island.

The estimated cost of this project was as follows:

For a channel 400 feet wide and 12 feet deep, at mean low water, 232,900 cubic yards (in place) of dredging, at 35 cents	$81,515
For an additional depth of 1 foot for a width of 200 feet, 117,300 cubic yards (in place) of dredging, at 30 cents	35,190
	116,705
Contingencies	9,000
Total	125,705

The dikes were estimated to cost $60,000, bringing up the total estimated cost of the proposed improvement to $185,000.

This project was approved, and bids for dredging were opened November 30, 1880, and a contract was awarded to Messrs. Morris & Cumings, the lowest bidders, at 19¼ cents per cubic yard. Work under this contract was begun December 22, 1880, and with the exception of a stoppage of about two months in the winter, it was continued up to the close of the fiscal year, during which time 101,368 cubic yards of material had been removed, giving a channel from 50 to 200 feet wide and 13 feet deep, extending from deep water east of Shooter's Island to a point 700 feet west of the Corner Stake Light and up to the eastern end of dike built in 1874 and 1875.

No appropriation was made during the fiscal year ending June 30, 1881, but there was a balance of the previous appropriation available of $28,538.84 at that date; and work under the contract with Morris & Cumings was continued up to December 2, 1881, when the contract was closed. During this time 116,931 cubic yards of material were removed, making the total amount removed under that contract 218,299 cubic yards.

This gave the channel a width of 200 feet and a depth of 13 feet to the eastward of Shooter's Island, and on the western side 200 feet wide and 13 feet deep.

During the dredging the character of the bottom was found to vary considerably in different parts of the channel.

In the vicinity of the Corner Stake Light there was a bed of compacted sand, gravel, shingle with bowlders occasionally imbedded in it, and the same formation without the bowlders was found at a point opposite Elizabethport.

Through the rest of the channel and east of Shooter's Island the bottom was soft mud.

No work was done up to the close of the fiscal year ending June 30, 1882, after the Morris & Cumings contract was completed.

By act of Congress passed August 2, 1882, $40,000 were appropriated for this work.

Bids for continuing the dredging were opened September 22, 1882, and the contract was awarded to Morris & Cumings, the lowest responsible bidders, at 23¾ cents per yard. Work under it was begun October 16, 1882, and the contract was closed May 16, 1883; during which time 158,637 cubic yards of material was removed from the channel. This completed the projected dredging.

A channel 400 feet wide and 13 feet deep for the central 200 feet, and 12 feet deep for 100 feet on each side, had been obtained from the deep water in the Kill von Kull east of Shooter's Island to deep water in the Arthur Kill off Elizabethport. But in the Annual Report of the Chief of Engineers for 1883, page 575, it was recommended that the depth should be increased to 13 feet for the full width of 400 feet. The estimated amount of material to be removed to do this was 50,000 yards, for which $25,000 was asked.

No work was done during the fiscal year ending June 30, 1884.

By act of Congress approved July 5, 1884, $10,000 were appropriated, and proposals for continuing dredging were opened September 17, 1884.

The contract was awarded to Messrs. Brainard & Benton, the lowest bidders, at 20 cents per cubic yard. They began work October 6 and finished it December 26, 1884, during which time 44,953 cubic yards were removed from the channel, and the existing channel widened to 400 feet, with a depth of 13 to 14 feet around the bend at the Stake Light, and from Shooter's Island eastward to the Kill von Kull.

In the Annual Report of the Chief of Engineers for 1884 and 1885 the construction of Dike B, on the north side of the channel off Elizabethport (see sketch in Annual Report of the Chief of Engineers for 1881, Part I, page 696), was advocated in order to check the deposits forming continually around the Stake Light. A careful examination of the Annual Reports and maps shows that the shoaling in this channel, considering the natural tendency to it, caused by the meeting of tides and currents in it, is singularly small.

A recent examination shows, practically, no change of depth since the last dredging.

The opposition to the building of the dike in 1878 was so determined that it is probable that similar opposition would arise if the construction of Dike B were begun.

The channel does not appear to be shoaling, and appears to be of ample depth for existing commerce. Its width, however, is not quite sufficient at two points, one at the bend off the Stake Light, and the other just east of Shooter's Island.

When the large Raritan River tows, of from 25 to 50 canal-boats, 5 abreast, get to these points, if there is much other commerce passing, there is almost always delay and trouble, and the channel here ought to be widened by dredging.

The construction of the dikes may be deferred until it is absolutely certain that they are required.

The appropriation of August 5, 1886, of $15,000 will be applied to widening the channel at these two points.

The commerce of this channel is very large. It is estimated that between 2,500,000 and 3,000,000 tons of coal are shipped yearly from Elizabethport, and that 5,750,000 tons of the Raritan Canal and Perth Amboy trade passes it, besides an immense amount of other freight.

A detailed statement may be found in Annual Report of the Chief of Engineers for 1884, page 744.

This last fiscal year the steamboat passenger traffic has been very much larger than usual. An appropriation of $15,000 is recommended for continuing the improvement.

APPROPRIATED.

Date.	Application.	Amount.
June 23, 1874	Diking	$50,000
August 14, 1876	Dredging	10,000
June 18, 1878	do	15,000
June 14, 1880	do	29,000
August 2, 1882	do	40,000
July 5, 1884	do	10,000
	Total	154,000

Amount expended, $154,000.

NOTE.—The $50,000 appropriated June 23, 1874, was expended in diking, so that of the revised estimate of 1881 only $104,000 have been appropriated, leaving $91,000 to be appropriated for the existing project.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Bergen Point Light. Nearest fort, Fort Tompkins. Amount of revenue collected at the port of New York for fiscal year ending June 30, 1886, $132,536,402.02.

Original estimate, 1873	$443,210
Revised estimate, 1881	185,705

Money statement.

July 1, 1885, amount available	$397 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	397 47
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,000 00
Amount (estimated) required for completion of existing project	91,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

E 25.

IMPROVEMENT OF PASSAIC RIVER, NEW JERSEY.

The Passaic is one of the most important rivers of New Jersey, passing through the large manufacturing towns of Paterson, Dundee, Passaic, Belleville, and Newark. Its course is very crooked down to Passaic, whence its direction is generally southeast to the mouth below Newark, where its junction with the Hackensack, coming from the north, forms what is known as Newark Bay. The lower end of Newark Bay has two outlets, one the Kill von Kull, towards the east, connecting it with New

York Harbor, and the other, the Arthur Kill, or Staten Island Sound, towards the south, connecting it with Raritan Bay.

The Passaic is a tidal stream for 13 miles above the mouth, up to Dundee Dam, 1 mile above Passaic. This dam was built by a private company some years ago for the purpose of securing uninterrupted water communication from Newark up to Paterson by means of a canal around some heavy shoals. The canal has never been opened to traffic, and is, as well as the reservoir above the dam, only used for water-power.

The city of Newark is situated about 4 miles above the mouth of the Passaic.

Since 1880 the appropriations for this river have been divided, one part being applied to that part of the river above Newark, and the other to that part of the river below Newark, including the channel through Newark Bay. The dividing line between these two improvements is the Pennsylvania Railroad Bridge at Market street in the city of Newark.

(1) *Above Newark, New Jersey.*—the first survey of this part of the river was ordered by act of March 3, 1871, and was made in 1872 under direction of General (then Lieut. Col.) John Newton, Corps of Engineers. The report on this survey may be found in Annual Report Chief of Engineers for 1872, page 805.

The condition of the river at that time from Clark's Spool Factory, above the Pennsylvania Railroad Bridge, up to Passaic, was a shallow, rocky stream, with shifting sand and gravel bars interspersed with bowlders. The depth of water over these bars gave only 2½ to 3 feet at mean low water, the range of tide at Passaic being 3 feet, and at Newark 4.7 feet. These bars were separated by pools and reaches having from 8 to 10 feet water on them.

The worst of these bars were:

Locality.		Distance above Pennsylvania Railroad Bridge.
Middle Bar, in the city of Newark	feet	9,000
Belleville Bar	miles	3
Rutherford Park Bar	do	6½
Holsman's Bar	do	7

There were other minor bars above Holsman's.

The project based upon this survey was to obtain by dikes and dredging, from the spool factory in Newark up to the head of navigation, a channel 100 feet wide and 6 feet deep at mean low water. The estimated cost of this work was:

Locality.	Application.	Amount.
Middle Bar	Dredging	$436
Do	Diking	66,875
Belleville Bar	Dredging	15,501
Rutherford Park Bar	do	14,112
Holsman's Bar and other small bars	do	12,000
	Contingencies	15,000
Total		123,924

In addition to this estimate, which was called that for "limited" improvements, a second estimate was given for extended improvements of $251,359, the first estimate being for a "partial" remedy for the obstacles to navigation, the second a "thorough" remedy.

The first appropriation for the improvement of the river was made by act of June 10, 1872, $25,000, and under it, after advertisement, a contract was let to Morris & Cumings, November 22, 1872, for dredging at Belleville Bar, and work was begun in the spring of 1873. On commencing work, outcroppings of bed rock of indurated sandstone and shale were encountered in many places, and up to the close of the fiscal year ending June 30, 1873, only 4,719 cubic yards of material had been removed. This was placed along the eastern side of the channel dredged, so as to form a dike parallel with the channel. The material removed was used in building 750 feet of dike.

By act of June 10, 1873, $25,000 was appropriated, and, after advertisement, proposals were opened for dredging the bar at Rutherford Park. The lowest bidder was James Caler, and a contract was made with him for opening a cut through the bar 2,900 feet long, 50 feet wide, and 6 feet deep.

The contract in force with Morris & Cumings for dredging the Belleville Bar at the close of the fiscal year ending June 30, 1873, was extended first to December 31, 1873, and again to June 30, 1874, and at the close of the fiscal year they had removed 5,820½ cubic yards of stone and bowlders, and 3,807¼ cubic yards of sand and gravel. The contractor was not required under the contract to take out solid rock, but as very much of this, consisting of indurated sandstone and shale, was found as the work progressed, a small scow was purchased in August, 1873, by the Government and fitted with one of the steam drilling engines used in connection with the drilling and blasting at Hell Gate and put on the work. So far as was known June 30, 1874, all the rock had been broken up by the scow and mostly removed, but no survey had been made.

On Rutherford Park Bar work was continued throughout the year, except during the winter. At the close of the fiscal year the work was nearly completed, so the contract was extended to September 1, 1874. Bed rock of the same character as in Belleville Bar was found on Rutherford Park Bar, and some surface blasting was necessary.

By act approved June 23, 1874, $20,000 was appropriated for continuing the improvement.

Early in the fiscal year ending June 30, 1875, Morris & Cumings finished their contract of November 22, 1872, for dredging the Belleville Bar, having made a cut through it 2,300 feet long and 7.5 feet deep. The upper 1,800 feet of the cut was 75 feet wide, from which point it gradually widened to 120 feet at the lower end.

The work at Rutherford Park Bar was also completed in December, 1874, under the contract with James Caler, the total length of the cut being 2,900 feet, with a width of 50 feet, and a depth of 6 feet at mean low water.

The drill-scow, worked by hired labor, removed one large rock and several small bowlders from the channel opposite Passaic.

Under date of March 3, 1875, $20,000 was appropriated for continuing the improvement, and the drill-scow was set at work early in the fiscal year ending June 30, 1876, removing some rock and bowlders in the channel at the Belleville Bar. The burning of the Midland Railroad Bridge August 1, 1875, caused a shoaling of the river both above and in the draw-span.

The drill-scow also did a little work on Rutherford Park Bar, consisting of blasting off projecting points of rock. After this, the scow was taken to Holsman's Bar, and commenced removing the stone from the reef, followed by a dredge hired by the day. This work continued up to the close of the fiscal year ending June 30, 1876, when a cut 40 feet wide at bottom, 1,300 feet long, and 6 feet deep at mean low water had been excavated through the reef.

A small bar above Holsman's, 300 feet long, was also excavated by the dredge.

By act of August 14, 1876, $10,000 was appropriated for continuing the improvement, but as it did not become avai able until April 1, 1877, little was accomplished during the fical year ending June 30, 1877.

In May, 1877, the drill-scow was taken to Belleville and Rutherford Park bars to remove bowlders and loose stones from the sides of the cuts, and up to the close of the fiscal year 395 cubic yards of material had been removed, clearing up 6̇5 feet of channel, and the same class of work was carried on over these bars during 1877 and 1878. A small shoal near the Erie Railroad Bridge was also removed.

June 18, 1878, an appropriation of $10,000 was made, and the drill-scow was set to work in August, 1878, near the bridge of the Midland Railroad, and removed a quantity of railroad iron, ties, and stone, which obstructed the channel and draw of the bridge. The cuts through Holsman's and other bars down to and through the Erie Railroad Bridge were widened 60 feet at the bottom with a dredge hired by the hour, the amount of material removed being 5,200 cubic yards of sand and gravel and 270 cubic yards of clay. After this work was done the dredge went down to the Midland Railroad Bridge, and removed 1,440 cubic yards of clay and stone from the channel and draw of the bridge.

During the months of April and May, 1879, the drill-scow removed 470 cubic yards of bowlders from the river near Passaic.

By act of Congress approved March 3, 1879, $2,000 was appropriated for the improvement, making a balance available June 30, 1879, of $4,562.69.

By act of June 14, 1880, $2,000 more was made available.

During the fiscal year ending June 30, 1880, the only operations consisted in making a channel 40 feet wide and 240 feet long through a gravel, bowlder, and stone bar opposite the Lodi Chemical Dock, about 1 mile above Passaic, with the drill-scow, and removing an old pier of the New York, Lake Erie and Western Railroad Bridge, which obstructed navigation, the railroad company agreeing to pay for the latter work.

Based upon the recommendation of General Newton, in 1879, a survey of the Passaic from the Midland Railroad Bridge to the mouth was made, and to which part of the funds available June 30, 1879, were applied.

At this date, June 30, 1880, General Newton (page 538, Annual Report Chief of Engineers, for 1880, Part I) states that a clear 6-foot channel had been obtained from the Midland Railroad Bridge to Passaic; 75 to 120 feet wide at Belleville Bar and 7.5 feet deep; 75 feet wide at Rutherford Park Bar and 6 feet deep; 60 feet wide at Holsman's Bar and 6 feet deep, and that the dike at Belleville was 1,800 feet long.

During the fiscal years ending June 30, 1881 and 1882, no work was done.

By act of August 2, 1882, $7,000 was appropriated, making the amount available at that date, with the balance of the old appropriation, $9,452.62.

No work was done during the fiscal year ending June 30, 1883. But an examination of the river in the spring of 1883 showed that from the Midland to the Erie Railroad Bridge, a distance of about 2 miles, there had been shoaling of the channel; and sealed proposals, after advertisement, were opened July 23, 1883, for dredging a 7.5-foot channel through these shoals, 100 feet wide. The work was let to Mr. Frank

Pidgeon, jr., the lowest bidder, at 38¾ cents per yard. Work was commenced September 4, 1883, and was completed December 9, 1883, during which time 19,190 cubic yards of sand and gravel were excavated.

Two cuts were made, one 1,400 feet long, 60 feet wide, and 7.5 feet deep, above Clark's Spool Factory Dock, and one above Point Pleasant, abreast of Lime Kiln Dock, 2,370 feet long, the upper part 60 feet wide and the lower 75 feet wide.

During this fiscal year a survey of the Passaic River, with a view to its improvement from Dundee to Paterson, N. J., was made under act of August 2, 1882, and a report submitted April 10, 1884.

By act of July 5, 1884, $3,000 were appropriated, and bids were opened for the widening to 75 feet of Middle Bar and Limekiln Bar, dredged the previous year to 60 feet.

Richard Parrott was the lowest bidder, at 49 cents per cubic yard; but owing to the lateness of the season, work was not commenced under his contract till June 10, 1885. At the close of the fiscal year the channel at Limekiln Bar had been widened to 75 feet by the excavation of 1,945 cubic yards of material.

The contract was completed early in the fiscal year ending June 30, 1886, after the channel at Middle Bar had been widened to 75 feet, by the excavation of 1,029 cubic yards of material. Some bowlders in the draws of the Midland Railroad Bridge were also excavated.

The recommendation was made last year for $5,000 to extend the 7.5-foot channel down to the Erie Railroad Bridge at Newark, and $2,250 was appropriated by act of August 5, 1886.

A recent examination shows the channels to be in good condition, and, in view of the smallness of the appropriation and the lateness of the season, it would be better to wait till next spring to see if the ice during the winter makes any marked changes in the channels before deciding where to apply the appropriation.

The extension of the bulkheads along the water-fronts of the city of Newark seem to render unnecessary the dike projected at Middle Bar.

In 1882 a project was started to put a dam across the river at Belleville to protect the interests of the water supply of Jersey City, but the matter has been in the hands of the courts for several years and nothing has been decided.

The commerce of the Upper Passaic above Centre Street Bridge is considerable, consisting in brick, coal, lumber, lime, cement, sulphur, building-stone, ice, and sundries.

The trade has materially increased of late years, and reference may be had to the commercial statistics published in Annual Report Chief of Engineers for 1884, Part I, page 739.

APPROPRIATIONS.

Date.	Application.	Amount.
June 10, 1872	Dredging at Belleville Bar	$25,000
Mar. 3, 1873	Dredging at Rutherford Park Bar	25,000
June 23, 1874	Dredging on all the bars above Belleville	20,000
Mar. 3, 1875	Removing bowlders at Rutherford Park and Belleville	20,000
Aug. 14, 1876	Removing bowlders at Rutherford Park and Belleville	10,000
June 18, 1878	Dredging at Holsman's Bar and removing obstructions	10,000
Mar. 3, 1879	Dredging above Passaic	2,000
June 14, 1880	Dredging between Midland & Erie Railroad Bridge	2,000
Aug. 2, 1882	do	7,000
July 5, 1884	do	3,000
Aug. 5, 1886	Allotment	2,250
	Total	126,250

Amount expended, $123,762.04.

Money statement.

July 1, 1885, amount available	$2,272 26
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,034 30
July 1, 1886, amount available	237 96
Amount appropriated by act approved August 5, 1886	2,250 00
Amount available for fiscal year ending June 30, 1887	2,487 96
Amount (estimated) required for completion of existing project	7,512 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,512 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(2) *Below Newark, New Jersey.*—In a project of operations submitted April 18, 1879, for the Passaic River, it was recommended by General (then Col.) John Newton, Corps of Engineers, that a survey of the river should be made from the Midland Railroad Bridge to the mouth, as no survey of it had been made by the Engineer Department up to that time, except for a short distance below the Midland Railroad Bridge.

The project was approved by the Chief of Engineers May 9, 1879, and the survey was made under General Newton in that year. The report upon the survey can be found in Annual Report Chief of Engineers for 1880, page 537. Soon after the report was made the Board of Trade of Newark urged the deepening of the channel from the Pennsylvania Railroad Bridge to the mouth of the river, a distance of about 4 miles, and over which there existed at that time a minimum depth of about 7 feet in a narrow channel. As the commerce of Newark seemed to warrant a depth of 10 feet in the channel, General Newton submitted the following estimate for obtaining and maintaining a channel 200 feet wide and 10 feet deep at mean low water from the Pennsylvania Railroad Bridge to the mouth of the river in Newark Bay, as follows:

Locality.	Application.	Amount.
From Pennsylvania Railroad Bridge to Zinc Works.	28,000 cubic yards of dredging, at 20 cents	$5,600
	1,500 linear feet of dike, at $8	12,000
From Zinc Works to Toll Bridge	100,000 cubic yards dredging, at 20 cents	20,000
	1,200 linear feet of dike, at $8	9,600
	4.800 linear feet of pile dike at $7.50	36,000
From Toll Bridge to Newark Bay	168,000 cubic yards dredging, at 20 cents	32,600
	4,300 feet of pile dike, at $9	38,700
	4,000 feet of pile dike, at $12	48,000
	Contingencies, engineering, &c.	30,375
	Total	232,875

The proposed line of dike from the mouth into Newark Bay did not follow the old channel to the westward of Passaic Light, but swung out from the right bank in a gentle curve to the north and east of the light, which would not only increase the scour from the Passaic and Hackensack along the new channel, but reach the deep water of Newark Bay sooner.

By the act of June 14, 1880, $30,000 were appropriated for this improvement; and, after advertisement, bids were opened for the construction of 2,000 feet of the dike at the mouth, to be built of two rows of creosoted piles, set 8 feet apart from center to center and filled with stone, the piles to have a penetration of 20 feet, and a contract was let to the lowest bidder, Henry Du Bois Sons, at $9.25 per linear foot of dike.

Work commenced November 26, 1880, and 2,002½ linear feet of it was completed May 10, 1881. It was built in two sections, one of 1,143 and the other of 859½ feet, with a space of 407½ feet between them, where its line crossed the old channel.

By act of March 3, 1881, $50,000 was appropriated, but it was decided not to commence dredging the channel along the dike till the whole 2,000 feet of dike should be completed. As soon as the contract for diking was closed, a contract was let, after advertisement, to Mr. E. M. Payn for dredging the channel along the line of the dike into Newark Bay, at 13.9 cents per cubic yard.

The dredging was begun May 23, 1881, and by the close of the fiscal year 19,263 cubic yards of material had been excavated, giving a channel 50 feet wide and 10 feet deep from the 8-foot curve in the river to the deep water in Newark Bay. This contract was closed August 24, 1881, and under it a total of 55,999 cubic yards had been excavated, giving a channel 10 feet deep and 125 feet wide.

On June 23, 1881, proposals were opened, after advertisement, for continuing the extension of the dike, and the contract was awarded to Henry Du Bois Sons, at $13.25 per linear foot. Work was commenced under this contract October 22, 1881, and closed January 31, 1882, during which time 2,003¼ feet of dike was completed, giving it a total length of 4,005¾ feet.

Bids were opened October 18, 1881, for further dredging in the channel, and the contract awarded to Elijah Brainard, the lowest bidder, at 10¾ cents per cubic yard. Work under this contract commenced November 14, 1881, and, with a three months' suspension in winter on account of ice, was still in progress at the close of the fiscal year ending June 30, 1882, during which time 97,853 cubic yards of material were excavated, giving a channel 200 feet wide and 10 feet deep from the deep water of the bay 3,900 feet up-stream. Work under this contract continued up to November 26, 1882, when the contract was closed. The total amount of material excavated under it was 173,986 cubic yards, which carried the channel with full width and depth from the bay through the draws of the Newark and New York Railroad Bridge, and the outlet into the bay was widened to 400 feet for a few hundred feet.

The act of August 2, 1882, appropriated $43,000 for continuing the improvement, and, after advertisement, sealed proposals were opened September 1, 1882, for continuing dredging, and the contract was awarded to the lowest bidders, Morris & Cumings, at 22½ cents per yard. Work was begun October 23, 1882, and continued up to and was still in progress at the close of the fiscal year ending June 30, 1883, the amount of material removed up to that time being 55,007 cubic yards.

In order to give shipping the immediate benefit of the improved channel, the width originally proposed of 200 feet was reduced to 130 feet for a distance of 1,000 feet above the Newark and New York Railroad Bridge, and to 100 feet for a further distance of 6,000 feet up-stream.

Up to the close of this fiscal year, under the different contracts, a total of 284,992 cubic yards of material had been removed from the channel since the beginning of the work, and the original amount estimated to give a 10-foot channel 200 feet wide from the mouth up to the Pennsylvania Railroad Bridge was 291,000 cubic yards, measured in place; but owing to the material being measured in scows and to having to dig a little below the depth and the side slopes, the original estimate, it is stated on page 573, Annual Report Chief of Engineers for 1883, Part I, would have to be largely increased.

No appropriation was made during the fiscal year ending June 30, 1884, but with the balance of the appropriation of 1882 work was continued under the contract with Morris & Cumings up to May 27, 1884, when the contract expired. Since June 30, 1883, to that date 110,221 cubic yards of material were excavated, making a total number of yards removed from the channel under it of 165,228. With this a channel 10 feet deep and from 100 to 125 feet wide had been carried up-stream from the end of last year's work to the Pennsylvania Bridge.

During the winter of 1883-'84 the shore end of the dike was damaged by ice, and $591.40 were spent on its repair by hired labor.

In his annual report for 1884 Colonel Gillespie (then in charge) estimates that the completion of the existing project for dredging a 200-foot channel in the river 10 feet deep and building 5,000 feet of dike opposite the zinc works would cost $85,000, but he calls attention to the fact that shoals existed in Newark Bay with less water on them than in the dredged channel of the river, and that if the 10 foot channel were extended down the bay the cost would be, approximately—

8,000 feet of pile-diking, at $12	$96,000
100,000 cubic yards dredging, at 25 cents	25,000
Total	121,000

and that therefore $150,000 (exclusive of the $25,000 appropriated by act of July 5, 1884) was asked for to complete a channel 200 feet wide and 10 feet deep in the river and through the shoals in the bay.

This appropriation of July 5, 1884, was wholly applied to the bay.

After advertisement, sealed proposals were opened September 17, 1884, and a contract was awarded to Henry Du Bois Sons, the lowest bidder, for building 700 feet, more or less, of dike extension, at $18 per foot, and for dredging 70,000 cubic yards, more or less, from the shoal in Newark Bay.

Work on the extension of the dike commenced November 13, 1884, and 699 feet had been completed by May 15, 1885, when the contract was closed. This extension gave the dike a total completed length of 4,705 feet.

Du Bois's contract for dredging was extended to September 1, 1885, and on the 30th of June, 1885, 34,509 cubic yards of material had been excavated, giving a channel through the shoal of 10 feet deep at mean low water, 100 feet wide, and 2,000 feet long.

The dike, at a point about 2,000 feet from the shore end, was damaged during the winter by an ice-jam, and arrangements were being made to have it repaired by the contractors.

No appropriation was made during the year ending June 30, 1886, but with the balance of the appropriation of 1884 dredging the shoal in the bay was continued under the contract in force up to December 19, 1885, during which time 28,056 cubic yards were excavated, making a total excavated from this shoal under the contract of 62,565 cubic yards, and giving a channel through the shoal of 2,000 feet long, 200 feet wide, and 10 feet deep, so that 10 feet at mean low water could be carried up to Newark Bay and up the Passaic River to the Pennsylvania Railroad Bridge in Newark.

The repairs necessary to the dike mentioned in 1885 were made by hired labor at a cost of $1,309.65. Of the existing project, at the close of the fiscal year ending June 30, 1886, the following work remained to be done:

Extension of the dike in Newark Bay 7,300 feet, and a light extension 1,000 feet long built at the head of the dike to protect the bank.

The dike in the river opposite the zinc works, 5,000 feet long, has not been commenced, and the channel from the Newark and New York Railroad Bridge up to the Pennsylvania Railroad Bridge, which now has a width of from 100 to 130 feet, should be dredged to full width of 200 feet. The estimated cost of this work is given in 1884 as $125,000.

A recent examination shows the dike and the channels to be in good condition, and the allotment of $24,000 from the appropriation of August 5, 1886, for this part of the river and the bay will be applied to extending the dike in Newark Bay southward, at ruling rates heretofore. This amount should build about 1,000 feet, and leave a little over for any contingencies that may arise.

The city of Newark has a population of 150,000 persons and has 1,400 manufacturing establishments.

The commerce of the river has slightly increased since the improvement commenced, and is done mostly in vessels drawing over 10 feet, and steamboats.

In 1882, 22,000 vessels passed the draw of the Newark and New York Railroad, with freight worth $1,000,000.

In 1883, 20,581 vessels passed the draw of the Newark and New York Railroad, with freight worth $1,000,000.

In 1884, 22,986 vessels passed the draw of the Newark and New York Railroad, with freight worth $1,200,000.

During the past two years it has been said to be about the same.

APPROPRIATIONS.

Date.	Application.	Amount.
June 14, 1880	Building 4,000 feet of dike at the mouth	$30,000
March 3, 1881	Dredging at the mouth and up the river	50,000
August 2, 1882	Dredging in the river	43,000
July 5, 1884	Building 699 feet of dike at mouth and dredging in Newark Bay	25,000
August 5, 1886	Allotment	24,000
		172,000

Amount expended, $147,427.18.

The original estimate was $232,875.

But this did not include the $121,000 estimated to be required in the modified estimate of 1884 for continuing the improvement through the shoal in Newark Bay.

Passaic River is in the collection district of Newark, which is the nearest port of entry; nearest light-house, Passaic Light, at the lower end of the dike in Newark Bay. Fort Tompkins is the nearest fort. Amount of revenue collected during the fiscal year ending June 30, 1886, $2,326.70.

Money statement.

July 1, 1885, amount available	$6,711 12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,138 30
July 1, 1886, amount available	572 82
Amount appropriated by act approved August 5, 1886	24,000 00
Amount available for fiscal year ending June 30, 1887	24,572 82
Amount (estimated) required for completion of existing project	181,875 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	125,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

INDEX.

SUBJECT.	Page.			
	Part I.		Part II.	Part III.
A.				
Advisory Harbor Commission at Philadelphia	123		849	
Ahnapee Harbor, Wis., improvement of	297			1662
Alabama River, improvement of	201		1171	
Allegheny River, Pa., improvement of	273			1544
Allegheny River, lock and dam at Herr's Island	273			1545
Alpena Harbor, Mich., improvement of	321			1825
Altamaha River, Ga., improvement of	186		1105	
Amite River, La., improvement of	213		1239	
Annapolis Harbor, Md., improvement of	134		877	
Ann, Cape, Mass., construction of harbor of refuge at Rockport	67	580		
Apalachicola Bay, Fla., improvement of	193		1140	
Apalachicola River, Fla., improvement of	196		1153	
Appomattox River, Va., improvement of	150		958	
Aqueduct bridge across Potomac at Georgetown, examination of	148		931	
Aransas Pass and Bay, Tex., improvement of	226		1330	
Archer's Hope River, Va., improvement of	152		962	
Arkansas River, from Fort Gibson to Wichita, survey of	244		1391	
Arkansas River, from Little Rock to its mouth, survey of	244		1389	
Arkansas River, at Pine Bluff, improvement of	238		1375	
Arkansas River, operations of snag-boats on	238		1371	
Ashland Harbor, Wis., in Ashland Bay, Lake Superior, examination and survey of	301			1674
Ashley River, S. C., improvement of	179		1080	
Ashtabula Harbor, Ohio, improvement of	337			1871
Au Sable Harbor, Mich., improvement of	321			1825
B.				
Baltimore, defenses of	28			
Baltimore Harbor, improvement of entrance to	133		874	
Bangor Harbor, Me., improvement of	55	530		
Battalion of Engineers	53	489		
Bay of Superior, Wis., improvement of	288			1632
Bayou Bartholomew, La. and Ark., improvement of	231		1353	
Bayou Black, La., improvement of	217		1261	
Bayou Bœuf, La., improvement of	231		1354	
Bayou Courtableau, La., improvement of	218		1263	
Bayou D'Arbonne, La., improvement of	232		1356	
Bayou La Fourche, La., improvement of	219		1266	
Bayou Macon, La., improvement of	232		1355	
Bayou Pierre, La., survey of	229		1343	
Bayou Teche, connecting with Grand Lake	216		1259	
Bayou Teche, La., improvement of	215		1245	
Bayou Terrebonne, La., improvement of	219		1264	
Beaufort, N. C., to New Berne, inland navigation between, improvement of	163		983	
Beaufort, N. C., defenses of	33			
Beaufort Harbor, N. C., improvement of	164		986	

Subject.	Page.			
	Part I.		Part II.	Part III.
Belfast Harbor, Me., improvement of	56	535		
Belle River, Mich., ice harbor at	324			1837
Big Black River, Miss., improvement of	236		1365	
Big Hatchie River, Tenn., improvement of	236		1366	
Big Sandy River, W. Va. and Ky., improvement of	284			1618
Big Sunflower River, Miss., improvement of	234		1359	
Biloxi, Miss., improvement of harbor at	209		1205	
Black Lake Harbor, Mich., improvement of	314			1768
Black River, Ark. and La., improvement of	230		1351	
Black River, Ark. and Mo., improvement of	240		1377	
Black River Harbor, Ohio, improvement of	333			1861
Black Rock Harbor, Conn., improvement of	87	640		
Black Warrior River, Ala., improvement of	208		1199	
Blackwater River, Va., improvement of	152		961	
Block Island, R. I., construction of harbor of refuge at	77	609		
Board of Engineers, special, on fortifications, &c		499		
Board of Engineers for Fortifications and for River and Harbor Improvements	48			
Bœuf River, La., improvement of	231		1354	
Boston, Mass., defenses of	12			
Boston Harbor, Mass., improvement of	63	564		
Brazos River, Tex., improvement of mouth of	225		1327	
Brazos Santiago, Tex., improvement of harbor at	226		1334	
Breton Bay, Md., improvement of	140		901	
Bridge, Aqueduct, at Georgetown, D. C., examination of	148		931	
Bridge, new, across Potomac River at Washington, D. C., plans for			892	
Bridge across Alabama River at Selma, Ala	370			2136
Bridge across Mississippi River at Keithsburg, Ill	369			2111
Bridge across Mississippi River at Minneapolis, Minn	369			2111
Bridge across Ohio River at Cairo, Ill	369			2116
Bridge across Ohio River at Henderson, Ky	370			2137
Bridging navigable waters of the United States	369			2111
Bridgeport Harbor, Conn., improvement of	86	644		
Broad Creek, Del., improvement of	128		863	
Broadkiln River, Del., improvement of	128		862	
Brown, Fort, Tex., protection of river bank at	227		1336	
Brunswick Harbor, Ga., improvement of	187		1112	
Buckhannon River, W. Va., improvement of	286			1684
Buffalo Bayou, Tex., improvement of	225		1325	
Buffalo Harbor, N. Y., improvement of	340			1881
Burlington Harbor, Vt., improvement of	349			1903
Buttermilk Channel, New York Harbor, improvement of	97	720		
C.				
Cahaba River, Ala., improvement of	202		1173	
Calcasieu River and Pass, La., improvement of	220		1276	
Caloosahatchee River, Fla., improvement of	196		1152	
Calumet Harbor, Ill., improvement of	307			1704
Calumet River, improvement of	308			1707
Canal at the Cascades, Columbia River, Oreg., construction of	358			1946
Canal at Des Moines Rapids, Mississippi River	253		1465	
Canal, Hennepin, additional surveys for	309			1708
Canal, Louisville and Portland, operating and maintaining	277			1574
Canal, Muscle Shoals, Tennessee River, construction of	265			1510
Canal, Saint Clair Flats, Mich	324			1827
Canal, Saint Mary's Falls, Mich	319			1783
Canarsie Bay, N. Y., improvement of	101	746		
Cane River, La., improvement of	230		1349	

Subject.	Page. Part I.		Page. Part II.	Page. Part III.
Caney Fork River, Tenn., improvement of	269			1523
Cape Ann, Mass., construction of harbor of refuge at Rockport	67		580	
Cape Fear River, N. C., improvement of, below Wilmington	168		1000	
Cape Fear River, N. C., improvement of, from Wilmington to Fayetteville	166		995	
Cedar Keys Harbor, Fla., improvement of	195		1148	
Cedar River, Mich., improvement at mouth of	293			1650
Channel between Staten Island and New Jersey, improvement of	110	788		
Charenton Canal, Saint Mary's Parish, La., improvement of	216		1259	
Charleston, S. C., defenses of	34			
Charleston Harbor, S. C., improvement of	176		1063	
Charlevoix Harbor, Mich., improvement of	309			1755
Charlotte Harbor, N. Y., improvement of	342			1887
Chattahoochee River, Ala. and Ga., improvement of	200		1168	
Cheboygan Harbor, Mich., improvement of	320			1824
Cheesequakes Creek, N. J., improvement of	106	763		
Chehalis River, Wash., improvement of	364			2009
Chesapeake Bay, removals of wrecks in	135		878	
Chester River, Md., at Kent Island Narrows, improvement of	130		866	
Chester River, Md., from Spry's Landing to Crumpton, improvement of	130		866	
Chicago Harbor, Ill., improvement of	306			1701
Chickahominy River, Va., improvement of	145		920	
Chippewa River, Wis., improvement of	258		1486	
Chippewa River at Yellow Banks, Wis., improvement of	259		1488	
Choctawhatchee River, Fla. and Ala., improvement of	203		1176	
Choptank River, Md., improvement of	131		868	
Cincinnati, Ohio, construction of ice harbor near	275			1549
Clearwater River, Idaho, improvement of Lower	360			1952
Cleveland Harbor, Ohio, improvement of	394			1863
Clinch River, Tenn., improvement of	268			1521
Clinton Harbor, Conn., improvement of	83	634		
Clinton River, Mich., improvement of entrance to	325			1842
Coanjok Bay, N. C., improvement of	154		965	
Cocheco River, N. H., improvement of	59	548		
Cohansey Creek, N. J., improvement of	122		847	
Colorado River, Cal. Nev. and Ariz., improvement of	356			1929
Columbia River, Oreg., construction of canal at the Cascades	358			1942
Columbia River, Oreg., defenses of	47			
Columbia River, Lower, Oreg., improvement of	357			1938
Columbia River, Oreg., improvement of mouth of	360			1971
Columbia River, Upper, and Snake River, Oreg., improvement of	359			1949
Columbia River, above mouth of Snake River, survey of	360			1953
Columbia River, Oreg., water-gauges on Lower	365			2010
Conecuh-Escambia River, Fla. and Ala., improvement of	203		1175	
Conneaut Harbor, Ohio, improvement of	338			1873
Connecticut River, above Hartford, Conn., improvement of	81	623		
Connecticut River, below Hartford, Conn., improvement of	82	625		
Contentnia Creek, N. C., improvement of	159		973	
Coosa River, Ala. and Ga., improvement of	200		1165	
Coosawattee River, Ga., improvement of	199		1165	

Subject.	Page. Part I.	Page. Part II.	Page. Part III.
Coos Bay, Oreg., improvement of entrance to	361		1969
Coquille River, Oreg., improvement of mouth of	362		2003
Corsica Creek, Md., improvement of	131	867	
Courtableau Bayou, La., improvement of	218	1263	
Cowlitz River, Wash., &c., improvement of	359		1952
Cumberland River, above the mouth of the Jellico, Ky., improvement of	267		1517
Cumberland River, Ky., South Fork of, improvement of.	270		1585
Cumberland River, Tenn. and Ky., improvement of	266		1515
Cumberland Sound, Fla. and Ga., defenses of	37		
Cumberland Sound, Fla. and Ga., improvement of entrance to	189	1118	
Currituck Sound, improvement of	154	965	
Cypress Bayou, Tex. and La., improvement of	229	1347	
D.			
Dan River, Va. and N. C., improvement of	146	925	
D'Arbonne Bayou, La., improvement of	232	1356	
Davis Island, lock and dam, Ohio River, operating and care of	272		1546
Defenses of the northern frontier	5		
Defenses, sea-coast and lake frontier, general remarks on and estimates for	4		
Delaware Breakwater Harbor, improvement of	119	839	
Delaware Bay, construction of ice-harbor at head of	118	834	
Delaware Bay and River, removal of wrecks from	123	847	
Delaware River:			
between Trenton and its mouth, improvement of	113	801	
at Schooner Ledge, improvement of	115	828	
near Cherry Island Flats, improvement of	115	829	
Des Moines Rapids Canal, Mississippi River, operating and care of	254	1468	
Des Moines Rapids Canal, Mississippi River, dry dock at	254	1477	
Des Moines Rapids, Mississippi River, improvement at.	253	1465	
Detroit River, Mich., improvement of	326		1842
Dorcheat Bayou, La., improvement of	230	1350	
Dry Tortugas Harbor, Fla., defenses at	39		
Dubuque, Iowa, improvement of harbor at	252	1424	
Dubuque, Iowa, ice-harbor at	252	1426	
Duck Creek, Del., improvement of	126	859	
Duck River, Tenn., improvement of	269		1593
Duluth Harbor, Minn., improvement of	287		1627
Dunkirk Harbor, N. Y., improvement of	338		1874
Duties and rank of officers of the Corps of Engineers.	375		
E.			
Eagle Harbor, Mich., improvement of	291		1643
East Chester Creek, N. Y., improvement of	91 663		
East River, N. Y., removal of obstructions from	95 675		
Echo Harbor, New Rochelle, N. Y., improvement of	89 655		
Edenton Bay, N. C., improvement of	154	963	
Edisto River, S. C., improvement of	179	1082	
Elizabeth River, N. J., improvement of	110 785		
Elk River, W. Va., improvement of	281		1598
Engineer depot and post at Willets Point	52 471		
Engineers, battalion of	53 489		
Engineers, Board of, for Fortifications and for River and Harbor Improvements	48		
Engineers, School of Application at Willets Point, N. Y.	52 471		
Erie Harbor, Pa., improvement of	339		1879

Subject.	Page. Part I.	Page. Part II.	Page. Part III.
Escambia River, Ala., and Fla., improvement of	203	1175	
Estimates for surveys and examinations, and contingencies of rivers and harbors	365		
Explorations and reconnaissances in military divisions and departments	372		
Explorations and reconnaissances, estimates for, in military divisions and departments	373		
F.			
Fairport Harbor (Grand River), Ohio, improvement of	336		1868
Falls of Saint Anthony, Minn., preservation of	255	1479	
Falls of the Ohio River, improvement of, navigation at	276		1569
Feather River, Cal., improvement of	355		1926
Fernandina and Saint John's River, Fla., deepening the inside passage between	190	1124	
Fishways at Great Falls of Potomac River	368		2061
Flint River, Ga., improvement of	199	1162	
Flushing Bay, N. Y., improvement of	91 661		
Fort Brown, Tex., protection of river bank at	227	1336	
Fortifications, report of special board on	50 499		
Fox and Wisconsin rivers, improvement of	304		1686
Frankford Creek, Pa., improvement of	116	829	
Frankfort Harbor, Mich., improvement of	310		1737
French Broad River, N. C., improvement of	147	929	
French Broad River, Tenn., improvement of	268		1520
G.			
Galveston, Tex., defenses of	45		
Galveston Bay, ship channel in, improvement of	224	1322	
Galveston Harbor, Tex., improvement of entrance to	223	1291	
Gasconade River, Mo., improvement of	247	1396	
Gedney's Channel, New York Harbor, N. Y	98 724		
Georgetown and Washington harbors, D. C., improvement of	135	879	
Georgetown Harbor, S. C., improvement of	172	1027	
Goose Rapids, Red River of the North, Minn. and Dak.	262	1500	
Gowanus Bay, N. Y., improvement of	98 722		
Grand Haven Harbor, Mich., improvement of	314		1766
Grand Marais, Mich., harbor of refuge at	292		1646
Grand Marais, Minn., improvement of, harbor at	289		1637
Grand River, Mich., improvement of	314		1766
Grass River, N. Y., improvement of, at Massena	347		1898
Great Kanawha River, W. Va., improvement of	279		1589
Great Kanawha River, W. Va., construction of harbor of refuge at mouth of	275		1550
Great Pee Dee River, S. C., improvement of	169	1017	
Great Sodus Harbor, N. Y., improvement of	344		1890
Green Bay, Wis.. improvement of harbor at	296		1658
Green Jacket Shoal, Providence River, R. I., removal of	75 605		
Greenport Harbor, N. Y., improvement of	90 658		
Guyandotte River, W. Va., improvement of	285		1629
H.			
Hampton Roads, Va., defenses of	30		
Harbor of refuge, Block Island, R. I., construction of	77 609		
Harbor of refuge, Bell River, Mich., construction of	324		1837
Harbor of refuge near Cincinnati, Ohio, construction of.	275		1549
Harbor of refuge, Grand Marais, Mich	292		1646
Harbor of refuge, Great Kanawha River, W. Va., construction of	275		1549

Subject.	Page.		
	Part I.	Part II.	Part III.
Harbor of refuge, Lake Pepin, Mississippi River, construction of	251	1422, 1424	
Harbor of refuge, Milwaukee Bay, construction of	301		1679
Harbor of refuge, Portage Lake, Lake Michigan, construction of	310		1752
Harbor of refuge, Sand Beach, Lake Huron	322		1829
Harbor of refuge, Sandy Bay, Cape Ann, Mass., construction of	67 580		
Harbor of refuge, Stonington, Conn., construction of	78 614		
Harbor of refuge, Sturgeon Bay Canal, Wis., construction of	296		1660
Harbor of refuge, Wood's Holl, Mass., construction of	69 591		
Harlem River, N. Y., improvement of	94 672		
Hay Lake Channel, Saint Mary's River, Mich., improvement of	318		1777
Hell Gate, N. Y., improvement of navigation at	95 675		
Hennepin Canal, additional surveys of	309		1703
Hiawassee River, Tenn., improvement of	267		1519
Horn Island Pass, Miss., improvement of	210	1206	
Housatonic River, Conn., improvement of	85 642		
Hudson River, N. Y., improvement of	92 665		
Humboldt Bay and Harbor, Cal., improvement of	353		1919
Huron Harbor, Ohio, improvement of	332		1858
Hyannis Harbor, Mass., improvement of	68 585		
I.			
Ice-harbor at Belle River, Mich., construction of	324		1837
Ice-harbor, near Cincinnati, Ohio, construction of	275		1549
Ice-harbor at head of Delaware Bay	118	834	
Ice-harbor at Dubuque, Iowa	252	1426	
Ice-harbor at Marcus Hook, Pa., construction of	117	832	
Ice-harbor at mouth of Muskingum River	274		1546
Ice-harbor at New Castle, Del	125	858	
Illinois River, improvement of	308		1705
Indian River, Del., improvement of	129	864	
Inland navigation from New Berne to Beaufort, N. C., improvement of	163	983	
Inside passage between Fernandina and Saint John's River, Fla., improvement of	190	1124	
J.			
James River, Va., improvement of	137	887	
Jetties at South Pass of the Mississippi River, inspection of	212	1225	
Jonesport, Me., improvement of Moos-a-bec Bar at	55 533		
K.			
Kanawha River, Great, improvement of	279		1589
Kanawaha River, Great, construction of harbor of refuge at mouth of	275		1550
Kanawha River, Little, improvement of	285		1623
Kennebec River, Me., defenses of	8		
Kennebunk River, Me., improvement of	57 543		
Kenosha Harbor, Wis., improvement of	303		1684
Kent Island Narrows, Md., improvement of	130	866	
Kentucky River, Ky., improvement of	282		1603
Kentucky River, Ky., operating and keeping in repair lock and dams on	283		1610
Kewaunee Harbor, Mich., improvement of	297		1663

SUBJECT.	Page.			
	Part I.		Part II.	Part III.
Keyport Harbor, N. J., improvement of	105	760		
Key West, Fla., defenses of	38			
Key West, Fla., improvement of harbor at	194		1144	
L.				
La Fourche Bayou, La., improvement of	219		1266	
La Grange Bayou, Fla., improvement of	204		1178	
Lake Bisteneau, La., improvement of	230		1350	
Lake City, Minn., construction of harbor of refuge at	251		1424	
Lake Huron, harbor of refuge on, at Sand Beach, Mich	322			1829
Lakes, northern and northwestern, issue of charts of	371			
L'Anguille River, Ark., improvement of	243		1388	
Laws of Forty-ninth Congress, first session, affecting Corps of Engineers	395			
Leonardtown Harbor, Md., improvement of	140		901	
Lewes, Del., construction of piers at	118		836	
Little Harbor, at Portsmouth, N. H., improvement of	59			
Little Kanawha River, W. Va., improvement of	285			1623
Little Narragansett Bay, R. I., and Conn., improvement of	78	613		
Little Sodus Harbor, N. Y., improvement of	344			1891
Little Tennessee River, improvement of	270			1524
Loggy Bayou, La., improvement of	230		1350	
Louisville and Portland Canal, operating and maintaining	277			1574
Lower Clearwater River, Idaho, improvement of	360			1952
Lower Willamette and Columbia rivers, Oreg., improvement of	357			1938
Lubec Channel, Me., improvement of	54	527		
Ludington Harbor, Mich., improvement of	312			1761
Lynn Harbor, Mass., improvement of	65	577		
M.				
Malden River, Mass., improvement of	66	579		
Mamaroneck Harbor, N. Y., improvement of	90	657		
Manasquan River, N. J., improvement of	102	751		
Manatee River, Fla., improvement of	195		1150	
Manistee Harbor, Mich., improvement of	311			1759
Manistique Harbor, Mich., improvement of	293			1649
Manitowoc Harbor, Wis., improvement of	299			1667
Mantua Creek, N. J., improvement of	121		844	
Maps, military and geographical, preparation of	371			
Marcus Hook, Pa., improvement of ice-harbor at	117		832	
Marquette Harbor, Mich., improvement of	291			1645
Matagorda Bay, Tex., improvement of entrance to	225		1328	
Mattaponi River, Va., improvement of	143		915	
Mattawan Creek, N. J., improvement of	105	761		
Maurice River, N. J., improvement of	124		855	
Meeker's Island, Minn., lock and dam at	257		1485	
Meherrin River, N. C., improvement of	155		965	
Menomonee Harbor, Mich. and Wis., improvement of	294			1652
Merrimac River, Mass., improvement of	61	560		
Michigan City Harbor, Ind., improvement of	316			1774
Military and geographical maps printed	371			
Milford Harbor, Conn., improvement of	85	640		
Milwaukee Bay, construction of harbor of refuge at	301			1673
Milwaukee Harbor, Wis., improvement of	302			1680
Minnesota River, Minn., improvement of	260		1494	
Mispillion Creek, Del., improvement of	127		861	
Mississippi (Lower) and Missouri rivers, operations of snag-boats on	244			1393

Subject.	Page.		
	Part I.	Part II.	Part III.
Mississippi River:			
above Falls of Saint Anthony, improvement of	256	1483	
at Des Moines Rapids, improvement of	253	1465	
at Dubuque, Iowa, improvement of	252	1424	
at Falls of Saint Anthony, improvement of	255	1479	
at Lake Pepin, construction of harbor of refuge	251	1422, 1424	
at Meeker's Island, Minn., construction of lock and dam	257	1485	
at Rock Island Rapids, improvement of	252	1427	
between the mouths of the Illinois and Ohio rivers, improvement of	249		
from Des Moines Rapids to mouth of Illinois River, improvement of	249, 251	1422	
from Saint Paul to Des Moines Rapids, improvement of	250	1412	
improvement of South Pass, inspection of	212	1225	
reservoir at sources of	363	1501	
snag-boats on, operations of	244	1393	
Upper, operations of snag-boats on	250	1403	
water-gauges on	237	1368	
Mississippi River Commission, report of	247		2143
Mississippi Sound, defense of	42		
Missouri River:			
between Sioux City and Fort Benton, improvement of	248		
snag-boats on, operations of	245	1394	
Missouri River Commission, report of	248		2167
Mobile, Ala., defenses of	41		
Mobile Harbor, Ala., improvement of	205	1183	
Mokelumne River, Cal., improvement of	355		1924
Monongahela River, improvement of	273		1542
Monongahela River, operating and care of lock and dam No. 9	273		1543
Monroe Harbor, Mich., improvement	326		1847
Moose-a-bec Bar, Jonesport, Me., improvement of	55 533		
Mount Vernon, Va., improvement of channel at	139	899	
Movable dam at Davis Island, Ohio River	272		1540
Muscle Shoals Canal, Tennessee River, construction of	265		1510
Muskegon Harbor, Mich., improvement of	313		1764
Muskingum River, construction of ice-harbor at	274		1546
Muskingum River, Ohio, improvement of	274		1547
Muskingum River, Ohio, examination and survey of	276		1551
N.			
Nantucket Harbor, Mass., improvement of	68 587		
Narragansett Bay, defenses of	14		
Narragansett Bay, R. I., improvement of	74 602		
Neabsco Creek, Va., improvement of	140	901	
Neches River, Tex., improvement of	222	1288	
Neuse River, N. C., improvement of	162	979	
New Bedford, Mass., defenses of	14		
New Berne and Beaufort, N. C., inland navigation between, improvement of	163	983	
Newburyport Harbor, Mass., improvement of	60 557		
New Castle, Del., ice-harbor at	125	858	
New Haven Harbor, Conn., construction of breakwater at	84 639		
New Haven Harbor, Conn., defenses of	17		
New Haven Harbor, Conn., improvement of	84 636		
New London Harbor, Conn., defenses of	15		
New London Harbor, Conn., improvement of	83 632		
New Orleans, La., defenses of	42		

Subject.	Page.		
	Part I.	Part II.	Part III.
Newport Harbor, R. I., improvement of	75 606		
New River, N. C., improvement of	165	991	
New River, Va., and W. Va., improvement of	281		1599
New Rochelle Harbor, N. Y., improvement at	89 654		
Newtown Creek, N. Y., improvement of	96 717		
New York Harbor, defenses of	17		
New York Harbor, Gedney's Channel in, improvement of	98 724		
Niagara River, N. Y., improvement of	341		1884
Nomini Creek, Va., improvement of	141	903	
Nootsack River, Wash., improvement of	364		2007
Norfolk Harbor, Va., and its approaches, improvement of	148	951	
Northern frontier, defenses of	5		
Northern and Northwestern Lakes, issue of charts of	371		
North Landing River, Va., and N. C., improvement of	153	962	
North River Bar, Currituck Sound, N. C., improvement of	154	965	
Norwalk Harbor, Conn., improvement of	88 649		
Nottaway River, Va., improvement of	151	961	
Noxubee River, Miss., improvement of	208	1201	
O.			
Oakland Harbor, Cal., improvement of	350		1907
Oak Orchard Harbor, N. Y., improvement of	342		1886
Obstructions to navigation, remarks on removal of	81 619		
Ocmulgee River, Ga., improvement of	198	1159	
Oconee River, Ga., improvement of	198	1161	
Oconto Harbor, Wis., improvement of	294		1653
Office of the Chief of Engineers	374		
Officers of the Corps of Engineers, number of duties of	3		
Ogdensburg Harbor, N. Y., improvement of	346		1895
Ohio River, construction of ice-harbor, near Cincinnati	275		1549
Ohio River, Davis Island lock and dam	272		1540
Ohio River, improvement of Indiana Chute at Falls of	276		1572
Ohio River, improvement of	271		1528
Ohio River, improvement of falls of	276		1569
Olcott Harbor, N. Y., improvement of	341		1885
Old Town Creek, Miss., improvement of	208	1200	
Ontonagon Harbor, Mich., improvement of	290		1641
Oostenaula River, Ga., improvement of	199	1165	
Osage River, Mo. and Kans., improvement of	246	1395	
Oswego Harbor, N. Y., improvement of	345		1892
Otter Creek, Vt., improvement of	350		1905
Ouachita River, La. and Ark., improvement of	230	1351	
P.			
Pamplico River, N. C., improvement of	156	966	
Pamunky River, Va., improvement of	144	917	
Pascagoula River, Miss., improvement of	209	1203	
Pascagoula River, Miss., from Moss Point to anchorage in bay, examination and survey of	211	1215	
Passaic River, N. J., above Newark, improvement of	111 793		
Passaic River, N. J., below Newark, improvement of	112 797		
Pass Cavallo Inlet, Tex., improvement of	225	1328	
Patapsco River, Md., improvement of	133	874	
Pawcatuck River, R. I., improvement of	80 616		
Pawtucket River, R. I., improvement of	73 596		
Pearl River, Miss., improvement of, between Edinburg and Carthage	211	1214	

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Pearl River, Miss., improvement of, below Jackson	210	1207	
Pearl River, Miss., improvement of, from Jackson to Carthage	210	1212	
Pease Creek, Fla., improvement of	195	1146	
Pee Dee River, Great, S. C., improvement of	169	1017	
Penobscot River, Me., defenses of	7		
Penobscot River, Me., improvement of	55 530		
Pensacola Harbor, Fla., defenses of	40		
Pensacola Harbor, Fla., improvement of	204	1179	
Pensaukee Harbor, Mich., improvement of	295		1656
Pentwater Harbor, Mich., improvement of	312		1762
Philadelphia Advisory Harbor Commission	123	849	
Philadelphia, Pa., defenses of	25		
Pier at Lewes, Del., construction of	118	836	
Plattsburg Harbor, N. Y., improvement of	348		1902
Plymouth Harbor, Mass., improvement of	64 571		
Portage Lake, Mich., construction of harbor of refuge at	310		1758
Port Chester Harbor, N. Y., improvement of	88 651		
Port Clinton Harbor, Ohio, improvement of	329		1854
Port Jefferson Harbor, L. I., N. Y., improvement of	90 660		
Portland Harbor, Me., defenses of	8		
Portland Harbor, Me., improvement of	57 538		
Portsmouth Harbor, N. H., defenses of	10		
Portsmouth Harbor, N. H., improvement of	58, 546, 541		
Port-warden's line at Philadelphia	123	849	
Port Washington Harbor, Wis., improvement of	300		1672
Post and depot at Willets Point	52 471		
Potomac River, improvement of, in vicinity of Washington, D. C	136	881	
Potomac River, fish-ways at Great Falls of	368		2061
Potomac River at Mount Vernon	139	899	
Providence River, R. I., improvement of	74 602		
Provincetown Harbor, Mass., improvement of	65 574		
Public buildings and grounds, District of Columbia	368		2075
Pultneyville Harber, N. Y., improvement of	343		1889
R.			
Raccoon River, N. J., improvement of	121	844	
Racine Harbor, Wis., improvement of	302		1682
Rahway River, N. J., improvement of	109 783		
Rancocas River, N. J., improvement of	120	841	
Rank and duties, officers of Engineers	375		
Rappahannock River, Va., improvement of	142	906	
Raritan Bay, N. J., improvement of	106 765		
Raritan River, N. J., improvement of	107 769		
Reconnaissances and explorations and estimates for	372		
Red River, La., improvement of	227	1337	
Red River of the North, improvement of	261	1496	
Red River of the North, construction of lock and dam at Goose Rapids	262	1500	
Redwood Harbor, Cal., improvement of	352		1914
Reservoirs at sources of the Mississippi River and its tributaries, construction of	263	1501	
Reservoirs at sources of the Mississippi River and its tributaries, surveys for	264	1507	
Rio Grande, Tex., protection of river banks at Fort Brown	227	1336	
River and harbor improvements	53		
Roanoke River, N. C., improvement of	147	927	
Rock Island Rapids, Mississippi River, improvement at	252	1427	
Rockland Harbor, Me., improvement of	56 536		
Rocky River, Ohio, improvement of	334		1862

Subject.	Page.		
	Part I.	Part II.	Part. III.
Romerly Marsh, Ga., improvement of water-route through	185	1102	
Rondout Harbor, N. Y., improvement of	94 670		
Rouse's Point, N. Y., construction of breakwater at	348		1899
S.			
Sabine Pass, Tex., improvement of	221	1278	
Sabine River, La. and Tex., improvement of	222	1287	
Sackett's Harbor, N. Y., improvement of	346		1894
Saco River, Me., breakwater at mouth of	58 546		
Saco River, Me., examination and survey of	60 552		
Sacramento River, Cal., improvement of	355		1926
Saginaw River, Mich., improvement of	322		1826
Saint Anthony, preservation of Falls of	255	1479	
Saint Augustine Creek, Ga., improvement of	185	1102	
Saint Augustine, Fla., defenses of	38		
Saint Clair Flats Ship-canal, Mich., repairs of	324		1837
Saint Clair Flats Ship-canal, Mich., operating and care of	325		1838
Saint Croix River, Wis. and Minn., improvement of	259	1490	
Saint Francis River, Ark., improvement of	242	1382	
Saint Jerome's Creek, Md., improvement of harbor at	141	904	
Saint John's River and Fernandina, Fla., deepening inside passage between	1	1124	
Saint John's River, Fla., improvement of bar at mouth of	190	1125	
Saint John's River, Fla., Upper, improvement of	191	1133	
Saint Jones River, Del., improvement of	126	860	
Saint Joseph's Harbor, Mich., improvement of	316		1771
Saint Mary's Falls Canal and Saint Mary's River, Mich., improvement of	319		1783
Saint Mary's Falls Canal, Mich., dry-dock at	320		1823
Saint Mary's Falls Canal, Mich., operating canal at	319		1809
Saint Mary's River, Mich., improvement of Hay Lake Channel	318		1777
Salem River, N. J., improvement of	122	846	
Saline River, Ark., improvement of	243	1367	
Salkiehatchie River, S. C., improvement of	180	1084	
Sand Beach, Mich., Lake Huron, harbor of refuge at	322		1829
San Diego, Cal., defenses of	45		
San Diego Harbor, Cal., improvement of	353		1917
Sandusky City Harbor, Ohio, improvement of	330		1855
Sandusky River, Ohio, improvement of	331		1857
Sandy Bay, Cape Ann, Mass., harbor of refuge at	67 580		
San Francisco, Cal., defenses of	45		
San Francisco Harbor, Cal., removal of wreck from	352		1915
San Joaquin River, Cal., improvement of	354		1921
Santee River, S. C., improvement of	173	1030	
Saugatuck Harbor, Mich., improvement of	315		1769
Saugerties Harbor, N. Y., improvement of	93 669		
Savannah, Ga., defenses of	36		
Savannah River and Harbor, Ga., improvement of	181	1087	
Savannah River, Ga., above Augusta, improvement of	184	1100	
Savannah River, Ga., below Augusta, improvement of	183	1098	
School of Application, Battalion of Engineers	53 489		
Schuylkill River, Pa., improvement of	116	830	
Scituate Harbor, Mass., improvement of	62 562		
Scuppernong River, N. C., improvement of	158	969	
Sea-coast and lake frontier defenses, general remarks on and estimates for	4		

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Sheboygan Harbor, Wis., improvement of	299		1670
Sheepshead Bay, N. Y., improvement of	100 743		
Shenandoah River, Va. and W. Va., improvement of	139	891	
Shrewsbury River N. J., improvement of	103 756		
Skagit River, Wash., improvement of	364		2007
Snag-boats on the Arkansas, operations of	238	1371	
Snag-boats on the Lower Mississippi and Missouri, operations of	244	1393	
Snake River, Wash., improvement of	359		1949
Snohomish River, Wash., improvement of	364		2007
Snoqualmie River, Wash., improvement of	364		2007
Sodus Harbor, N. Y., Great, improvement of	344		1890
Sodus Harbor, N. Y., Little, improvement of	344		1891
South Forked Deer River, Tenn., improvements of	237	1367	
South Haven Harbor, Mich., improvement of	315		1770
South Pass, Mississippi River, inspection of improvement at	212	1225	
Southport Harbor, Conn., improvement of	87 648		
South River, N. J., improvement of	108 777		
Staten Island, N. Y., improvement of New Jersey Channel	110 788		
Staunton River, Va., improvement of	145 146	922, 924	
Steele's Bayou, Miss., improvement of	235	1363	
Steilaquamish River, Wash., improvement of	364		2007
Stockholm, Wis., construction of harbor of refuge at	251	1422	
Stonington Harbor, Conn., improvement of	78 614		
Sturgeon Bay Canal, Wis., harbor of refuge at	296		1660
Sumpawanus Inlet, L. I., N. Y., improvement of	102 748		
Sunflower River, Miss., improvement of	234	1359	
Superior Bay, Wis., improvement of	288		1632
Survey of Northern and Northwestern lakes, issue of charts of	371		
Surveys and examinations for improvement of rivers and harbors, estimates for	365		
Surveys, additional, for Hennepin Canal	309		1708
Susquehanna River, near Havre de Grace, Md., improvement of	129	864	
Suwanee River, Fla., improvement of	194	1143	
Swanton Harbor, Vt., improvement of	348		1901
T.			
Tallahatchie River, Miss., improvement of	234	1361	
Tallapoosa River, Ala., improvement of	201	1172	
Tampa Bay, Fla., improvement of	192	1137	
Tampa Bay, Fla., removal of wreck from	199	1159	
Tangipahoa River, La., improvement of	213	1241	
Tar River, N. C., improvement of	156	966	
Taunton River, Mass., improvement of	72 595		
Tchefuncte River, La., improvement of	214	1242	
Tchula Lake, Miss., improvement of	234	1360	
Teche Bayou, La., connection with Grand Lake, at Charenton	216	1259	
Teche Bayou, La., improvement of	215	1245	
Tennessee River, above Chattanooga, improvement of	264		1509
Tennessee River, below Chattanooga, improvement of	265		1510
Tennessee River, Little, improvement of	270		1524
Tensas River, La., improvement of	232	1355	
Terrebonne Bayou, La., improvement of	219	1264	
Tickfaw River, La., improvement of	215	1244	
Thames River, Conn., improvement of	82 629		
Thunder Bay Harbor, Mich	321		1885
Ticonderoga River, N. Y., improvement of	350		1905

Subject.	Page.			
	Part I.		Part II.	Part III.
Toledo Harbor, Ohio, improvement of	327			1849
Tombigbee River, Ala., improvement of	206		1196	
Torpedo defense	50			
Totusky River, Va., improvement of	142		913	
Tradewater River, Ky., improvement of	284			1617
Trent River, N. C., improvement of	160		976	
Trinity River, Tex., improvement of	224		1323	
Two Rivers Harbor, Wis., improvement of	298			1665
U.				
Umpqua River, Oreg., improvement of	363			2005
Upper Columbia and Snake rivers, Oreg. and Wash., improvements of	359			1949
Upper Mississippi River, operations of snag-boats on	250		1403	
Upper Thoroughfare, Deal's Island, and main	132		870	
Upper Willamette River, Oreg., improvement of	258			1940
Urbana Creek, Va., improvement of	143		914	
V.				
Vermillion Harbor, Ohio, improvement of	332			1859
Volusia Bar, Lake George, Fla., improvement of	192		1135	
W.				
Wabash River, Ind., improvement of	277			1582
Waccemaw River, N. C., improvement of	170		1022	
Wachita River, Ark. and La., improvement of	230		1351	
Wacissa River, Fla., examination and survey of	212		1220	
Wappoo Cut, S. C., improvement of	178		1077	
Wareham Harbor, Mass., improvement of	70	593		
Warren River, R. I., improvement of	75	605		
Warrior River, Ala., improvement of	206		1193	
Washington Aqueduct, D. C	365			2013
Washington, D. C., defenses of	29			
Washington and Georgetown harbors, D. C., improvement of	135		879	
Washington, D. C., improvement of Potomac River at	136		881	
Washington, D. C., increasing water supply of	366			2021, 2043
Wateree River, S. C. improvement of	174		1053	
Water-gauges on Mississippi River and its tributaries	237		1368	
Water-gauges on Columbia River, Oreg., and tributaries	365			2010
Waukegan Harbor, Ill., improvement of	303			1685
Westport Harbor, Mass., improvement of	70	592		
White River, Ark., improvement of	240		1378	
White River, Ark., above Buffalo Shoals, improvement of	241		1381	
White River Harbor, Mich., improvement of	313			1763
White River, Ind., improvement of	279			1586
Wicomico River, Md., improvement of	132		869	
Willamette River, Lower, Oreg., improvement of	357			1938
Willamette River, Upper, Oreg., improvement of	358			1940
Willets Point, N. Y., engineer post and depot at	53	489		
Wilmington Harbor, Cal., improvement of	351			1911
Wilmington Harbor, Del., improvement of	124		857	
Wilmington, N. C., defenses of	34			
Wilson Harbor, N. Y., improvement of	341			1885
Wisconsin and Fox rivers, improvement of	304			1686
Withlacoochee River, Fla., improvement of	197		1155	
Woodbridge Creek, N. J., improvement of	109	781		

SUBJECT.	Page. Part I.		Page. Part II.	Page. Part III.
Woodbury Creek, N. J., improvement of	121		843	
Wood's Holl Harbor, Mass., improvement of	69	591		
Wrecks in Cape Fear River, removal of	175		1060	
Wrecks in Chesapeake Bay, removal of	135		878	
Wrecks in Delaware Bay and River, removal of	123		847	
Wrecks in Fairport Harbor, Ohio, removal of	339			1876
Wrecks in New Orleans Harbor, La., removal of	223		1290	
Wrecks in North Carolina and Virginia, removal of	159		970	
Wreck in San Francisco Harbor, Cal., removal of	352			1915
Wreck in Scuppernong River, N. C., removal of	159		970	
Wreck in Tampa Bay, Fla., removal of	197		1157	
Wrecks off Cape Cod, removal of	80	618		
Wreck off entrance to Narragansett Bay	81	619		
Y.				
Yadkin River, N. C., improvement of	157		967	
Yalabusha River, Miss., improvement of	235		1362	
Yaquina Bay, Oreg., improvement of entrance to	362			1998
Yazoo River, Miss., improvement of	233		1357	
Yellowstone River, improvement of	249		1399	
York River, Va., improvement of	144		918	

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